UNITED NATIONS NATIONS UNIES

Conference on Climate Change and Official Statistics

Oslo, Norway, 14-16 April 2008

The United Nations Statistics Division (UNSD), in collaboration with the Statistical Office of the European Communities (Eurostat), the World Bank and Statistics Norway, will convene an international conference on climate change and official statistics.

Climate change is high on the political agenda at all levels. The global official statistics community presently engages the issues of climate change in an ad hoc manner. Some national statistical offices are heavily engaged and provide all official estimates required in the monitoring efforts. Some engage only in analytical efforts, principally to investigate the effects of mitigation protocols on national economy or the impact of climate change in planning scenarios. Many others have no activities at all related to this topic. There is a need to discuss how official statistics can contribute to the measurement and monitoring of the different aspects of climate change and to bring together all current activities into a coherent framework. This conference is therefore designed as a forum for the exploration of ideas and to establish an agenda for future work.

The output of the conference will be an agenda for action by the global official statistics community. The agenda will be submitted to the 40th session of the UN Statistical Commission for discussion and endorsement in 2009.

United Nations Statistics Division (UNSD)
Statistical Office of the European Communities (Eurostat)
the World Bank and **Statistics Norway**

http://unstats.un.org/unsd/climate_change/

UNITED NATIONS NATIONS UNIES

Conference on Climate Change and Official Statistics

Oslo, Norway, 14-16 April 2008

TABLE OF CONTENTS

INVITATION LETTER ………………………………….. 1
Paul Cheung, ***Director of the United Nations Statistics Division***

CONFERENCE PROVISIONAL PROGRAM………… 3

ORGANIZATION OF WORK…………………………... 9

LIST OF PARTICIPANTS……………………………….. 13

CONFERENCE ABSTRACTS…………………………... 19

CONFERENCE PAPERS……………………………….... 49

CONFERENCE PRESENTATIONS…………………….. 286

COUNTRY PAPERS…………………………………….. 1239

http://unstats.un.org/unsd/climate_change/

Conference on Climate Change and Official Statistics

Oslo, Norway, 14-16 April 2008

INVITATION LETTER

Paul Cheung, ***Director of the United Nations Statistics Division***

CONFERENCE PROVISIONAL PROGRAM

ORGANIZATION OF WORK

CONFERENCE ABSTRACTS

SESSION 1: Setting the scope: Understanding the demand for statistics created by the scientific and policy framework of climate change and the role of official statistics in satisfying this demand.

SESSION 2: Greenhouse gas emission calculations as part of official statistics. What should be the role of NSO's in the estimation of greenhouse gas emissions and in informing adaptation and mitigation strategies? Are our statistics adequate?

SESSION 3: What is the role of official statistics in the measurement of the impacts of, vulnerability and adaptation to climate change?

SESSION 4: Carbon emission trading and other mitigation strategies.

SESSION 5: How can official statistics support climate change scenario development and modelling and better inform the IPCC's Fifth Assessment Report?

SESSION 6: Bringing it all together: Classifications, standards and frameworks for climate change statistics. Do indicator systems play a role? Are existing frameworks adequate? Do they need to be amended or extended? What needs to be done to ensure these frameworks can be applied by National Statistical Offices?

CONFERENCE PAPERS

COUNTRY PAPERS

CONFERENCE PRESENTATIONS

LIST OF PARTICIPANTS

United Nations Nations Unies

OFFICE OF THE DIRECTOR
STATISTICS DIVISION (UNSD)
DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS
TWO UNITED NATIONS PLAZA, DC2-1670, NEW YORK, NY 10017
TELEPHONE NO: 1 (212) 963-4598; FAX NO: 1 (212) 963-9851
Internet location: unstats.un.org/unsd

STAT 110 01 February 2008

Dear Colleague,

I would like to follow up on my letter of 11 January 2008 in which I had outlined plans for an international conference on climate change and official statistics to be organized by UNSD in collaboration with Eurostat, the World Bank and Statistics Norway. I am glad to inform you that we have received many positive responses to the proposal from national statistical offices (NSOs) as well as strong support from international organizations.

There seems to be a general agreement that there is an urgent need to discuss how official statistics can best contribute to the measurement, monitoring and analysis of climate change and associated impacts. It is timely to build an agenda for action by the official statistical community. This agenda, the key output of the conference, will be discussed at the 40th Session of the UN Statistical Commission in 2009.

I am writing to you now to officially announce that the Conference on Climate Change and Official Statistics will be held from 14 to 16 April 2008 in Oslo, Norway and to extend an invitation to you to attend and contribute to this event.

Please find attached for your information the provisional work programme of the Conference. As you will see, the sessions are built around the main aspects of climate change where official statistics can best contribute. There will be a strong presence of high level policy makers and scientists as well as statisticians to accentuate the frameworks that determine the need for and possibilities of official statistics to measure and monitor the causes and impacts of climate change and their relationship with development.

We already have acceptances from a number of excellent presenters including senior representatives from the Intergovernmental Panel for Climate Change, European Environment Agency, the World Bank, Organisation for Economic Co-operation and Development (OECD) and the statistical offices of Australia, Canada, Finland, Norway, and the Philippines.

The conference will be designed so there is plenty of time in the sessions for discussion between the participants and presenters. Please note that Sessions II, III and VII are expected to be longer than the other sessions. As we receive confirmations from invited speakers, a more detailed agenda will be gradually finalized.

A web page for the conference is on the UNSD web site (http://unstats.un.org/unsd/climate_change/). You are welcome to contribute country papers which should be submitted to Ms Eszter Horvath (horvath@un.org) by 28 February 2008 and will be placed on the web site as soon as possible.

Given the high level nature of the conference, we would like to recommend that NSOs be represented by the Director Generals or high level officials. Please note that this is not a technical conference where normally environmental statisticians would be represented. Since the capacity of the conference room is limited, there will be a maximum of two participants per country. Exceptions will be made for those countries providing presenters. We encourage you to invite a senior official from your country's environment policy agency as the second country representative.

The Conference will be held at the Oslo Military Society. The web link is http://www.oslomilitaeresamfund.no/index_eng.php. The Society's Conference Centre is about 150 meters from the Office of Statistics Norway.

All hotels within Central Oslo are reasonably close to the Conference Centre. Since April is a busy period for accommodation in Oslo it is suggested that you make your hotel reservations early. We attach a list of hotels recommended by Statistics Norway for your convenience. They have made some room reservations for the Conference at these hotels.

A registration form is attached for you to indicate who will represent your country at the Conference. To assist with planning, we would be grateful if you could send us your nominations by 22 February 2008 to Mr. Alain Gaugris (gaugris@un.org).

We are currently exploring the possibilities regarding funding for a limited number of participants from developing countries. If your attendance is dependent on funding, please indicate that on the registration form.

Should you have any questions regarding this conference, please send them to Ms. Eszter Horvath (horvath@un.org)

Thank you for your collaboration in this very important endeavor.

Yours sincerely,

Paul Cheung
Director
Statistics Division/DESA

April 11, 2008

Conference on Climate Change and Official Statistics

Oslo, Norway, 14-16 April 2008

ANNOTATED PROVISIONAL PROGRAM

MONDAY 14 APRIL

Opening: The Conference will be opened by Kristin Halvorsen, Minister of Finance for Norway. There will be short introductory speeches by the sponsoring organizations (Paul Cheung, UNSD; Marie Bohata, Eurostat; and Eric Swanson, World Bank) to outline their objectives for the Conference.

Session I: Setting the scope: Understanding the demand for statistics created by the scientific and policy framework of climate change and the role of official statistics in satisfying this demand.

Speakers will be Professor Mohan Munasinghe, Vice-President of the Intergovernmental Panel for Climate Change (IPCC), Jacqueline McGlade, Director of the European Environment Agency (EEA), and Alex Manson, Director-General, Strategic Policy Branch and Special Advisor on Climate Change of the Canadian National Ministry of Environment.

Session II: Greenhouse gas emission calculations as part of official statistics. What should be the role of NSO-s in the estimation of greenhouse gas emissions and in informing adaptation and mitigation strategies? Are our statistics adequate?

Statistics underlying the estimation of greenhouse gas emissions encompass and feed primarily on energy statistics, but also on a wide spectrum of statistics on basic activities such as, production of industrial commodities, agriculture, forestry, transport, international trade, land use, waste-water, wastes, etc. Detailed statistics on physical flows in these activities are needed for development of greenhouse gas emission inventories. Emissions (and removals) of greenhouse gases are calculated/estimated on the basis of activity data with the help of emission factors. The development of the methods of calculation/estimation and the establishment of the emission factors is usually outside the scope of official statistics. However, as these calculations require a large amount of official statistics, and the reliability of the calculations depend on the quality of these statistics, the NSO-s should be involved in the process (i) to understand better the special needs for statistics (ii) to make the other players (environmental ministries, research institutes etc) better understand the role of statistical standards, classifications and the advantage of their use.

There will be a presentation from the Astrid Olsson of the UN Framework Convention on Climate Change explaining the measurement frameworks that underlie the Kyoto protocol, outlining the expectations for these estimates and the main lessons from the review of existing estimates. This will be followed by presentations from several National Statistical Offices (Kathrine Loe Hansen, Statistics Norway; Riitta Pipatti, Statistics Finland; Santaram Mooloo and Anand Sookun of Mauritius, Konstantin Laykam, Federal State Statistics Service of the Russian Federation) that are involved in the estimation of greenhouse gas emissions. Robert Andres, Carbon Dioxide Information Analysis Center of the US Department of Energy will give a presentation on their emission calculations at the global, regional and national levels based on national energy statistics. Norihiko Yamano of the OECD will give a presentation on the use of input-output tables for the estimation of greenhouse gas emissions.

The Discussant will highlight the ways official statistics can improve the input data to provide more reliable and consistent GHG emission estimates.

TUESDAY 15 APRIL

Session III: What is the role of official statistics in the measurement of the impacts of, vulnerability and adaptation to climate change?

Measurement of the impact of climate change is to a large extent based on sources outside the statistical system. They include meteorological and hydrological information, physical environmental data and data from scientific research. In order to assess the impacts of climate change and the consequent adaptation and mitigation measures, however, this information has to be linked with existing statistics on the population, on human/economic activities and on the environment to enable Impacts on the economy, the society and the natural environment to be assessed. Furthermore, Statistical offices also have a role in the integration of different data sets to provide official statistics, such ***as indicator systems****, that might describe the vulnerability or adaptive capacity of a country to impacts of climate change. Impact analysis is usually outside official statistics and belongs to the field of modelling. But official statistics can still play an important role by providing the source data, or developing integrated statistical systems such* ***as environmental accounts****, as essential inputs into these models.*

This session will start with overview presentations of the impacts on different parts of the world and the associated measurement issues. There will be presentations from Atiq Rahman of the Bangladesh Centre of Advanced Studies (and a recent winner of the Earth Award), and Professor Jose Marengo of Brazil, a prominent IPCC climate scientist.

Subsequent presentations will be structured along the lines of impacts on the natural environment, the society and the economy.

The presentations on environmental impacts will look at three different aspects. Andre Jol of the European Environment Agency will look at ecosystem impacts. Peter Harper of the Australian Bureau of Statistics will describe their water accounts and how they might be used to analyse the demand and supply for water which has become more vulnerable as a result of climate change. The presentation of Sourav Chakrabortty, Central Statistical Office of India,

will describe the role of statistics in the Natural Disaster Recovery System under development. Sonya Ahamed from CIESIN, Columbia University will reflect on different environmental and social impacts.
The next group of papers will be concerned with agriculture, food security and other social aspects. There will be presentations by Eva Laczka of Hungary and Estrella Domingo of the Philippines National Statistical Co-ordination Board. Kseniya Lvovsky from the World Bank will speak about adaptation responses.

Four National Statistical Offices (Rob Smith, Statistics Canada; Walter Radermacher, Germany, Statistisches Bundesamt; Peter van de Ven, Statistics Netherlands; and Brita Bye, Statistics Norway) will speak about their approaches to the assessment of economic impacts.

Discussants will highlight the key statistical measurement issues and how National Statistical Offices can contribute to the measurement of impact of, vulnerability and adaptation to, climate change.

Session IV: Carbon emission trading and other mitigation strategies

Carbon Emission Trading will be one of the more important responses to Climate Change in many countries. What is the role of official statistics in supporting the carbon market? How can Statistical Offices support analysis that examines the implications of carbon trading on the economy and economic growth? How useful are the I-O Tables for such analysis?
How can official statistics contribute to the assessment of costs and benefits of, and tradeoffs between adaptation and mitigation policies, measures and instruments? Can we monitor their effectiveness and impacts?

There will be a presentation from Peter Harper of the Australian Bureau of Statistics which has been given additional resources to improve statistics that are relevant to the carbon emission trading scheme being establishes in Australia. Thomas Olsen, Statistics Denmark will give a presentation on how environmental accounts can be used to analyse the structural impact of introducing emission trading schemes. Kseniya Lvovsky from the World Bank will speak about carbon markets.

Many of the presentations in Sessions II and III will also touch upon mitigation and will be used as input into this session. In addition, Matthias Bruckner from the UN Division of Sustainable Development will speak about monitoring mitigation of climate change as part of monitoring sustainable development. There will be presentations from Xu Huaqing, Head of the Research Centre of Energy, Environment and Climate Change of China and Martin Nesbit of the Department of the Environment, Food and Rural Affairs of the United Kingdom.

Discussants will be chosen to highlight the key statistical measurement issues and how National Statistical Offices can best contribute.

WEDNESDAY 16 APRIL

Session V: How can official statistics support climate change scenario development and modelling and better inform the IPCC's Fifth Assessment Report?

Statistics used as input include population projections, economic growth and income, energy structure and other driving force statistics. There have been criticisms of some of the statistical assumptions in the scenarios. Perhaps Statistical Offices might be able to assist more in the Fifth Report.

Dennis Trewin will identify how official statistical community might be best able to assist with this important work. He will reflect on the key issues being considered for the Fifth Assessment Report identified in the opening session by Mohan Munasinghe.

Session VI: Bringing it all together: Classifications, standards and frameworks for climate change statistics. Do indicator systems play a role? Are existing frameworks adequate? Do they need to be amended or extended? What needs to be done to ensure these frameworks can be applied by National Statistical Offices?

Statistics to describe and monitor all aspects of climate change are manifold and come from multiple sources. There is a need for frameworks and standards that integrate statistics related to climate change and link official statistics with other information.

This session is intended to be very interactive with a small number of presentations to stimulate discussion. The discussion will commence with a presentation from Heinrich Bruengger of UN ECE on the possible roles of official statistics in the context of statistical information for climate change. Then the session will be broken up into three parts.

The first part will deal with spatial frameworks and their use in bringing together different types of information and official statistics. It will be highlighted by Gilberto Calvillo of INEGI, Mexico on their spatial framework and how it has been used to analyse the impacts or possible impacts of events relevant to climate change. Sonya Ahamed from CIESIN/Columbia University will make reference to their spatial information system.

The second part will deal with indicator systems and their use in bringing together different aspects of climate change. The Matthias Bruckner of the UN Division of Sustainable Development will give a presentation on their indicator systems and their relevance to climate change statistics. There will also be a presentation from Stephen Hall of the United Kingdom Department of the Environment on their indicator system.

The third part will deal with the implications for classifications, frameworks and standards. Alessandra Alfieri of UNSD will give a presentation on the System of Integrated Environmental-Economic Accounts and how it might be used to support analysis of climate change. In her presentation Viveka Palm of Statistics Sweden will highlight the implications for sectoral statistics. Other relevant statistical frameworks such as the Oslo Manual will also be considered at this part of the Conference.

Discussants will be chosen to highlight the advantages and disadvantages of the different approaches and how can they be used for different purposes.

Session VII: Conclusions and recommendations: Agenda for action

This session will be moderated by Walter Radermacher, President of the Federal Statistics Office of Germany. A draft agenda for action will be presented by Paul Cheung, Director of the UN Statistics Division as a focus for discussion. The output of this discussion is expected to be a recommended roadmap for the development of official climate change statistics both at the national and the international level, to be discussed at the 2009 session of the UN Statistical Commission.

Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

PROVISIONAL ORGANIZATION OF WORK

Monday 14 April

8:00 – 9:15 **Registration**

9:30 – 10:10 **Opening session** (40')
Chair: Oystein Olsen (Norway)
Speakers:
- Kristin Halvorsen (Norway)
- Paul Cheung (UNSD)
- Marie Bohata (Eurostat)
- Eric Swanson (WB)

10:10 – 10:30 Coffee break (20')

10:30 – 12:30 **Session One** (120')
Setting the scope: Understanding the demand for statistics created by the scientific and policy framework of climate change and the role of official statistics in satisfying this demand
Chair: Heli Jeskanen-Sundstrom (Finland)
Speakers:
- Mohan Munasinghe (IPCC)
- Jacqueline McGlade (EEA)
- Alex Manson (Canada)

Discussant: Inger Eklund (Sweden)
Discussion

12:30 – 1:30 Lunch break (60')

1:30 – 3:00	**Session Two** (90’) Greenhouse gas emission calculations as part of official statistics: What should be the role of NSO-s in the estimation of greenhouse gas emissions and in informing adaptation and mitigation strategies? Are our statistics adequate? Chair: Gilberto Calvillo (Mexico) Speakers: • Astrid Olsson (UNFCCC) • Kathrine Loe Hansen (Norway) • Riitta Pipatti (Finland) • Santaram Mooloo and Anand Sookun (Mauritius)
3:00 – 3:20	Coffee break (20’)
3:20 – 5:00	**Session Two** (continued) (100) Speakers • Konstantin Laykam (Russian Federation) • Robert Andres (US) • Norihiko Yamano (OECD) Discussant: Gerard O’Hanlon (Ireland) Discussion

Tuesday 15 April

9:00 – 10:00	**Session Three** (60’) What is the role of official statistics in the measurement of the impacts of, vulnerability and adaptation to climate change? Chair: Eric Swanson (WB) Speakers: • Atiq Rahman (Bangladesh) • Jose Marengo (Brazil) Discussion
10:00 – 10:20	Coffee break (20’)
10:20 – 12:30	**Session Three** (continued) (130’) Environmental impacts of climate change Social impacts of climate change Environmental

Speakers:
- Andre Jol (EEA)
- Peter Harper (Australia)
- Sourav Chakrabortty (India)
- Sonya Ahamed (CIESIN)

Social
Speakers:
- Estrella Domingo (Philippines)
- Eva Laczka (Hungary)
- Kseniya Lvovsky (World Bank)

Discussant: Kaia Oras (Estonia)
Discussant: Ben Kiregyera (UN ECA)
Discussion

12:30 – 1:30	Lunch break (60')
1:30 – 3:20	**Session Three** (continued) (110') Economic impacts of climate change Speakers: • Rob Smith (Canada) • Walter Radermacher (Germany) • Peter van de Ven (Netherlands) • Brita Bye (Norway) Discussant: Knut Thonstad (Norway) Discussion and Concluding discussion of Session Three
3:20 – 3:40	Coffee break (20')
3:40 – 5:50	**Session Four** (130') Carbon emission trading and other mitigation strategies Chair: Olav Ljones (Norway) Emission trading Speakers: • Peter Harper (Australia) • Thomas Olsen (Denmark) • Kseniya Lvovsky (World Bank) Other mitigation strategies Speakers: • Xu Huaquing (China) • Martin Nesbit (UK) • Matthias Bruckner (UN DSD) Discussant: Rob Smith (Canada) Discussion

Wednesday 16 April

9:00 - 9:40	**Session Five** (60') How can official statistics support climate change scenario development and modeling, and better inform the IPCC's Fifth Assessment Report? Chair: Eva Laczka (Hungary) Speaker: • Dennis Trewin (UNSD) Discussion
9:40 – 10:40	**Session Six** (60') Bringing it all together: Classifications, standards and frameworks for climate change statistics Chair: Dennis Trewin (UNSD) Speakers: • Heinrich Bruengger (ECE) A) Spatial frameworks • Gilberto Calvillo (Mexico) • Sonya Ahamed (CIESIN)
10:40 – 11:00	Coffee break (20')
11:00 – 12:20	**Session Six** (continued) (80) B) Indicator systems • Matthias Bruckner (UN DSD) • Stephen Hall (UK) C) Integrated environmental-economic accounting • Alessandra Alfieri (UNSD) • Viveka Palm (Sweden)
12:20 – 1:30	Lunch break (55')
1:30 – 2:30	**Session Six** (continued) (60') Discussant: Pieter Everaers (Eurostat) Discussant: Jordan *(to be confirmed)* Discussion
2:30 – 4:00	**Session Seven** (90') Conclusions and recommendations: Agenda for action Chair: Walter Radermacher (Germany) Speaker: • Paul Cheung (UNSD) Discussion

Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

Country, organization	Name	Institution	Title
Australia	Mr. Peter HARPER	Australian Bureau of Statistics	Deputy Australian Statistician
Bangladesh	Dr. A. Atiq RAHMAN	Bangladesh Centre for Advanced Studies (BCAS)	Executive Director
Belarus	Mr. Pavel SIRENSKY	Ministry of Statistics and Analysis	Adviser on Environmental Management, International Cooperation Department
Brazil	Mr. Wadih SCANDAR NETO	IBGE, Brazilian Institute of Geography and Statistics	Project Manager
Brazil	Ms. Marly SANTOS DA SILVA	Ministry of Environment	Coordinator of the Subcommittee of Statistics and Environmental Indicators of the National Information System on the Environment
Brazil	Mr. Jose Antonio MARENGO ORSINI	INPE, National Space Research Institute	Senior Scientist
Bulgaria	Ms. Mariana KOTZEVA	National Statistical Institute	President
Cameroon	Mr. Joseph TEDOU	National Institute of Statistics	General Manager
Canada	Mr. Robert SMITH	Statistics Canada	Director
Canada	Mr. Alex MANSON	Environment Canada	Director General, Strategic Policy Branch, and Special Advisor on Climate Change
China	Mr. Zhimin CHA	National Bureau of Statistics	Deputy Director-General, Department of Social, Science & Technology Statistics
China	Mr. Suoqiang LI	National Bureau of Statistics	Director, Division of Environmental Statistics Department of Social, Science & Technology Statistics
China	Mr. Huaqing XU	Center for Energy, Environment and Climate Change Research, Energy Research Institute National Development and Reform Commission	Director, Research Professor
Colombia	Mr. Pedro José FERNÁNDEZ AYALA	Departamento Administrativo Nacional de Estadística DANE	Deputy Director
Costa Rica	Mr. Juan CHAVARRIA	Instituto Nacional de Estadístca y Censos	Member of Board of Directors
Cyprus	Mr. George GEORGIOU	Statistical Service of Cyprus	Director
Denmark	Mr. Thomas OLSEN	National Accounts Division Statistics Denmark	Senior Adviser
Denmark	Mr. Bent THAGE	Statistics Denmark	Director
Egypt	Mr. Abdel Aziz ABDEL WAHAB	Environment Statistic Department CAPMAS	General Director
Estonia	Mrs. Kaia ORAS	Statistics Estonia	Head of Environment and Sustainable Development Statistics Service Economic Statistics Department
Ethiopia	Mr. Yasin MOSSA	Central Statistics Agency	Acting Economic Statistics Deputy Director General
Finland	Mrs. Heli JESKANEN-SUNDSTRÖM	Statistics Finland	Director General

Finland	Mrs. Riitta PIPATTI	Statistics Finland	Head of Statistics
Germany	Mr. Walter RADERMACHER	Statistiches Bundeamt (Federal Statistical Office)	President
Germany	Mr. Michael KUHN	Statistiches Bundeamt (Federal Statistical Office)	Head of Subdivision Environmental-Economic Accounting (EEA)
Hong Kong, China	Mr. Dominic K T LEUNG	Census and Statistics Department	Deputy Commissioner
Hong Kong, China	Mr. Vincent T F CHEUNG	Environmental Protection Department	Environmental Protection Officer
Hungary	Ms. Sandorne LACZKA	CSO	Head of Agricultural and Environmental Statistical Department
India	Mr. Sourav CHAKRABORTTY	Social Statistics Division Central Statistical Organisation Ministry of Statistics & Pianning	Deputy Director (in charge of Disaster Management Statistics)
Indonesia	Mr. MUDJIHANDOKO	BPS Statistik Indonesia	Director of Industrial Statistics
Ireland	Mr. Gerard O'HANLON	Central Statistics Office	Director General
Japan	Mr. Akihiro KIMOTO	Ministry of Internal Affairs and Communications	Director for International Statistical Affairs
Jordan	Mr. Gazi SHBAIKAT	Department of Statistics	Director General
Kazakhstan	Mr. Yuriy SHOKAMANOV	Agency on Statistics	Executive Secretary
Kuwait	Ms. Hessa I. Al-JANAHI	Central Statistical Office	Director
Kuwait	Ms.Amal AL-SHARRAH	Central Statistical Office	Statistical Analysis Specialist
Laos	Dr. Samaychanh BOUPHA	Ministry of Planning and Investment	Director General Department of Statistics(DoS)
Laos	Mr. Bounmy VILAYCHITH	Ministry of Planning and Investment	Acting Director of Division Department of Statistics (DoS)
Latvia	Ms. Aija ZIGURE	Central Statistical Bureau	President
Latvia	Mr. Juris FRIDMANIS	Latvian Environmental, Geology and Meteorology Agency	Head of Department on Environmental Pollution
Liberia	Mr. Kormay ADAMS	Government of Liberia / LISGIS	Director of Economic Statistics
Lithuania	Mrs. Vilija LAPĖNIENĖ	Statistics Lithuania	First Deputy Director General
Madagascar	Mr. Andriamampianina RAKOTONALALA	Ministry of Economy, Trade and Industry	Director General
Malaysia	Ms Wan Ramlah WAN ABO RAOF	Department of Statistics	Chief Statistician
Malaysia	Ms Zaidah ZAINAL ABIDIN	Department of Statistics	Statistician
Maldives	Ms. Aishath SHAHUDA	Ministry of Planning and National Development	Deputy Executive Director
Mauritius	Mr. Santaram MOOLOO	Ministry of Environment and National Development Unit	Ag. Deputy Director
Mauritius	Mr. Anand SOOKUN	CSO	Statistician - Environment and Energy
Mexico	Mr. Gilberto CALVILLO VIVES	INEGI	President

Morocco	Mme Kada SAKINA	Direction de la Statistique Haut Commissariat au Plan	Chef de Service des Publications Générales Coordinatrice nationale MEDSTAT Environnement
Netherlands	Mr. Petrus Johannes Maria VAN DE VEN	Statistics Netherlands	Director of National Accounts
New Zealand	Mr. Peter SWENSSON	Statistics New Zealand	Manager, Geography, Regional & Environment
Nigeria	Mr. Surajudeen ABAYOMI	National Bureau of Statistics	Chief Statistician (Environment Desk)
Paraguay	Ms. Zulma Concepcion SOSA DE SERVIN	Dirección General de Estadística, Encuestas y Censos (DGEEC)	Directora General
Philippines	Ms. Estrella V. DOMINGO	National Statistical Coordination Board (NSCB)	Secretary General
Poland	Mr. Josef OLENSKI	CSO	President
Qatar	Mr. Sultan Ali AL KUWARI	Statistics Authority	Director of Demographic, Social & Statistical Analysis Dept
Qatar	Mr. Abdel Hadi Ali HASSAN	Statistics Authority	Specialist Statistician
Republic of Korea	Mr. Seongho HAN	Korea National Statistical Office (KNSO)	Director Economic Statistics Division Statistical Research Institute
Republic of Korea	Ms. Hae Ryun KIM	Korea National Statistical Office (KNSO)	Deputy Director Economic Statistics Division Statistical research Institute
Russian Federation	Mrs. Natalia SHASHLOVA	ROSSTAT	Deputy Director
Russian Federation	Mr. Konstantin LAYKAM	ROSSTAT	Deputy Head of ROSSTAT
Saint Lucia	Mr. Edwin ST. CATHERINE	Government of St Lucia	Director of Statistics
Sierra Leone	Mr. Ibrahim G. KARGBO	Office of the Statistician General Statistics Sierra Leone	Senior Statistician (Energy and Environment)
Singapore	Mr. Teck Wong SOON	Singapore Department of Statistics	Director
Singapore	Ms. Hwee Peng CHAI	Singapore Department of Statistics	Senior Assistant Director
Singapore	Ms. Sin Shyan Cynthia LIM	Ministry of Trade and Industry	Senior Assistant Director (Energy Division)
Singapore	Mr. Ng Chang YUE	Ministry of the Environment and Water Resources	Policy Executive
Slovenia	Ms. Mojca SUVOROV	CSO	Director of Natural Resources, Environment and Regional Statistics
South Africa	Ms. Marguerite RICHARDSON	Department of Environmental Affairs and Tourism	Deputy Director Atmospheric Monitoring and Research
South Africa	Mr. Jairo ARROW	Statistics South Africa	
Spain	Ms. María Luisa EGIDO MARTÍN	Instituto Nacional de Estadística	Head of Department Subdirección General de Estadísticas Industriales y Agrarias
Sri Lanka	Mr. A. M. U. DISSANAYAKE	Director General of Census and Statistics	Director of Agriculture and Environment Statistics Division

Swaziland	Mr. Thembinkosi SHABALALA	Central Statistical Office	Senior Statistician
Sweden	Ms. Viveka PALM	Statistics Sweden	Coordinator of Environmental Accounts
Sweden	Ms. Inger EKLUND	Statistics Sweden	Director
Tonga	Mr. Atelaite Lupe MATOTO	Department of Environment Ministry of Lands, Survey and Natural Resources	Prinicipal Environment Officer
United Arab Emirates	Mr. Khamis RADDAD	Ministry of Economy	Environment & Agr. Expert
United Arab Emirates	Mr. Hamad Eissa AL ADHAB AL MATROWSHIE	Federal Environmental Agency	Head of EIA Department
United Kingdom	Mr. Stephen HALL	Department for Environment, Food and Rural Affairs (DEFRA)	Head of Sustainable Development Indicators
United Kingdom	Ms. Sarah HAWKES	Department for International Development	Statistical Advisor
United Kingdom	Mr. John MACKINTOSH	Department for Environment, Food and Rural Affairs (DEFRA)	Climate Change Statistical Co-ordinator Environment Statistics and Indicators
United Kingdom	Mr. Martin NESBIT	International Climate Change, DEFRA	Director Evidence
Vietnam	Mr. Thuc DO	General Statistical Office	Deputy General Director
Vietnam	Mr. Anh Kiem DO	General Statistical Office	Deputy Director of Social and Environmental Department
African Development Bank	Mr. Beejaye KOKIL	Economic & Social Statistics Division	Manager
CDIAC	Mr. Robert ANDRES	OAK Ridge National Lab	Senior R&D Staff
CIESIN/Columbia University	Ms. Sonya AHAMED	CIESIN Columbia University	
DESA/Division of Sustainable Development	Mr. Matthias BRUCKNER	DESA/Division of Sustainable Development	Sustainable Development Officer
European Environment Agency (EEA)	Mr. André JOL	European Environment Agency (EEA)	Head of Group Climate Change
European Environment Agency (EEA)	Ms. Jacqueline Myriam McGLADE	European Environment Agency (EEA)	Executive Director
EUROSTAT	Mr. Petrus Cornelis EVERAERS	EUROSTAT	Director
EUROSTAT	Mr. Gilles DECAND	EUROSTAT	Head of Unit Environment accounts and statistics
EUROSTAT	Ms. Julie HASS	EUROSTAT	National expert Environment statistics
EUROSTAT	Ms Marie BOHATA	EUROSTAT European Commission	Deputy Director General

InWEnt Capacity Building International	Mr. Uwe SINGER	InWEnt Capacity Building International	Senior Project Manager
IPCC	Prof. Mohan MUNASINGHE	IPCC	Chairman, Munasinghe Institute for Development (MIND) and Vice Chair, Intergovernmental Panel on Climate Change (IPCC)
OECD	Mr. Norihiko YAMANO	OECD	Administrator
UNECA	Mr. Ben KIREGYERA	UNECA Statistics Dept.	Director
UNECE	Mr. Heinrich BRUENGGER	UNECE	Director Statistics Division
UN-ECLAC	Mr. Humberto SOTO	UN-ECLAC	Environmental Affairs Officer Division of Sustainable Development and Human Settlements
UNEP	Mr. Jaap VAN WOERDEN	UNEP/DEWA/GRID-Geneva	
UNFCCC	Ms Astrid OLSSON	UNFCCC	Programme Officer
UN-HABITAT	Dr. Marco KEINER	UN-HABITAT	Chief, Urban Environment Section
UNIDO	Mr. Shyam UPADHYAYA	United Nations Industrial Development Organization	Chief Statistician
UNSD	Dr. Paul CHEUNG	United Nations Statistics Division	Director
UNSD	Mr. Dennis TREWIN	United Nations Statistics Division	Inter-Regional Advisor
UNSD	Ms. Eszter HORVATH	United Nations Statistics Division	Chief, Environment and Energy Statistics Branch
UNSD	Ms. Alessandra ALFIERI	United Nations Statistics Division	Chief, Environment Statistics Section
UNSD	Ms. Reena SHAH	United Nations Statistics Division	Environment Statistics Section
World Bank	Mr. Eric V. SWANSON	DEC Development Data Group World Bank	Program Manager
World Bank	Ms. Kseniya LVOVSKY	World Bank	Team Leader, Climate Change Environment Department
Norway	Mr. Gisle HAAKONSEN	The Ministry of the Environment	Advisor
Norway	Mr. Knut THONSTAD	The Ministry of Finance	Director, Secretariat for sustainable development
Norway	Mr. Torgrim ASPHJELL	The Norwegian Pollution Control Authority (SFT)	Senior adviser
Norway	Ms Gro HYLEN	The Norwegian Forest and Landscape Institute	Researcher
Norway	Mr. Øystein OLSEN	Statistics Norway (SSB)	Director General
Norway	Mr. Olav LJONES	Statistics Norway (SSB)	Deputy Director General
Norway	Ms Brita BYE	Statistics Norway (SSB)	Head of research, Unit for Economic Growth and Efficiency
Norway	Mr. Torstein BYE	Statistics Norway (SSB)	Director, Department of Economics, Energy and the Environment
Norway	Mr. Svein HOMSTVEDT	Statistics Norway (SSB)	Head of Division, Division for Environmental Statistics
Norway	Ms. Kathrine Loe HANSEN	Statistics Norway (SSB)	Senior Adviser, Division for Environmental Statistics
Norway	Ms. Kristin AASESTAD	Statistics Norway (SSB)	Adviser, Division for Environmental Statistics

Responsible for the practical organisation in Norway:			
Norway	Ms. Kari NYTRØEN	Statistics Norway (SSB)	Senior Executive Officer, Division for Personnel Administration
Norway	Ms. Désirée VIKSE	Statistics Norway (SSB)	Adviser, Division for Personnel Administration
Norway	Ms. Ingrid HORVERAK	Statistics Norway (SSB)	Adviser, International Secretariat
Norway	Ms. Marte O. KITTILSEN	Statistics Norway (SSB)	Senior Executive Officer, Division for Environmental Statistics

Conference Abstracts

SESSION 1: Setting the scope: Understanding the demand for statistics created by the scientific and policy framework of climate change and the role of official statistics in satisfying this demand

ABSTRACTS

Prof. Jacqueline McGlade
Director
European Environment Agency

EEA needs for climate change statistics

Reliable greenhouse gas emission data and indicators continue to be essential for policymakers to track progress to agreed emission reduction targets and analyze effectiveness of policies. Energy production and use statistics should have high accuracy, be available at national and also sub-national scales (such as cities) and be timely available for compilers of greenhouse gas inventories. Also other statistics are required such as on transport, industry, agriculture, land use and forestry. Managing adaptation to climate change provides new challenges. Increasing frequency and intensity of extreme weather events will require better seasonal data, for example in agriculture and forestry accounts and in the water sector. It will also require new geo-spatial statistics and indicators across scales, for example at river basin level, and for ecosystem functional units and services. For cost benefit analyses of mitigation and adaptation strategies new economic valuation approaches are needed for accounting ecosystem services in physical and monetary terms. Especially on costs of adaptation methodologies and data are needed on cost-effective measures. Statistical offices can help improving the required basic data and corresponding frameworks such as environmental accounting.

SESSION 2: Greenhouse gas emission calculations as part of official statistics. What should be the role of NSO's in the estimation of greenhouse gas emissions and in informing adaptation and mitigation strategies? Are our statistics adequate?

ABSTRACTS

Official statistics as data sources for national greenhouse gas inventories – classification issues and quality requirements

Riitta Pipatti
Statistics Finland
Greenhouse Gas Inventory Unit

The national greenhouse gas inventories are prepared according to the rules and modalities agreed in the United Nations Framework Convention for Climate Change (UNFCCC), the Kyoto Protocol and the EU Monitoring Mechanism for greenhouse gas emissions. National greenhouse gas inventories should be transparent, consistent, comparable, complete and accurate as well as timely. The inventories should be prepared using methodologies developed by the Intergovernmental Panel on Climate Change (IPCC). In addition, they should meet specific requirements on quality control and quality assurance measures as well as requirements on institutional, legal and procedural arrangements.

The inventories are reviewed annually by international expert review teams. The review process is a vital part for continuous improvement of the inventory as well as in assessing compliance with the commitments under the international agreements.

In Finland, Statistics Finland is responsible for the coordination, compilation and reporting of Finland's national greenhouse gas inventory. This work has gained much from the established statistical data validation processes and procedures, as well as from having good access to statistical data. The long-term experiences and knowledge gained from environmental and energy statistics have been an advantage. Good collaboration with the relevant ministries and the research community has also been an important factor for successful inventory preparation.

Greenhouse gas inventory preparation is heavily relying on data from national statistics. The timing and level of detail of statistical data don't always meet the needs of the inventories. Harmonisation of classifications (e.g. fuel classification for energy statistics

and greenhouse gas inventories), data collection and timetables has been important and increased the efficiency of both the inventory and the statistical processes.
The target of the paper is to describe and analyse the national inventory preparation from the view point of official statistics. Future demands for input from national statistics to the UNFCCC process and for the IPCC will also be discussed shortly. Provision of applicable and more specific data for scenario and climate strategy development, as well as providing input to monitoring impacts of climate policies and measures are areas where the role of statistical data could be strengthened.

The measurement of CO_2 embodiments in international trade: Evidence from the OECD Input-Output Tables for the mid 1990s – early 2000s

Satoshi Nakano[b], Asako Okamura[b], Norihisa Sakurai[c]
Masayuki Suzuki[b]; Yoshiaki Tojo[a], and Norihiko Yamano[a]

a) Economic Analysis and Statistics Division
Directorate for Science, Technology and Industry (DSTI), OECD
b) Global Security Research Institute, Keio University
c) Planning Group, Central Research Institute of Electric Power Industry

Efforts such as Kyoto protocol to reduce the greenhouse gas (GHG) emission which is linked to the global climate change might fail to reduce the global emission level of GHG, if the domestic productions of the ratified states relocate their production activities abroad, and/or substituted to import goods from non-energy efficient countries. Obviously, the increase in imports from more GHG intensive countries goes against the purpose of the protocols. This paper analyses the international transfer effects of GHG emissions using the input-output and bilateral trade data of OECD and energy statistics of IEA. The simulation result under base case scenario shows that 10 OECD countries have reduced the production basis CO2 emissions, and but the consumption basis emissions were increased in 25 OECD countries in 1995-2000. About half (54%) of the world increases in the CO2 emissions is produced in non-OECD countries, and the two-third of the increase in the consumption basis emissions has roots in the emissions by OECD countries. The net exports of CO_2 emissions in the early 2000s are negative in the large OECD countries such as the United States (-0.9Gt), Japan (-0.3Gt), and four large EU countries (the United Kingdom, Germany, Italy, and France: total -0.6Gt). On the other hand, four major non-OECD countries, Russia (0.6 Gt), China (0.5 Gt), Indonesia (0.06 Gt) and India (0.06 Gt) accounted for 80% of the non-OECD group's positive CO2 trade surplus.

The Use of UN-Supplied Fuel Production and Trade Statistics for the Estimation of Global and National Fossil-Fuel-Derived Carbon Dioxide Emissions

RJ Andres[1], TA Boden[1], G Marland[1, 2]
[1]Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6335 USA
[2]International Institute for Applied Systems Analysis
A2361 Laxenburg
Austria

andresrj@ornl.gov, bodenta@ornl.gov, marlandgh@ornl.gov

Statistics on the production, transfers, transformations, and consumption of fuel are collected by various governmental, public and private entities. These statistics are compiled by national statistical offices (NSOs). NSOs forward summaries of these statistics via questionnaires to international organizations such as the United Nations Statistics Division (UNSD) and the International Energy Agency (IEA). These international organizations then make these statistics available to the general public, government entities, private firms, and non-governmental organizations through a variety of means. These individual groups then use these statistics for a multitude of applications.

This talk will focus on one such application: the estimation of global and national carbon dioxide emissions from fossil-fuel consumption. In addition to the fossil fuel statistics, these estimates also rely on a knowledge of fuel chemistry and combustion conditions. Personnel at the Carbon Dioxide Information Analysis Center (CDIAC) at Oak Ridge National Laboratory (ORNL), USA, have for three decades made annual estimates of fossil-fuel-derived carbon dioxide emissions. New releases of the emissions data are made each year when another year of fuel statistics becomes available from the UNSD. This talk will briefly review how the emissions estimates are made on both a global and national basis. These estimates are only made after the completion of a quality assurance/quality control (QA/QC) procedure. The QA/QC procedure is an interactive process with the UNSD that helps ensure the UNSD fuel statistics release is internally consistent. The talk will then close with a brief description of a value-added product produced at CDIAC: the distribution of the national emissions at a one degree latitude by one degree longitude scale.

Reporting and review of GHG inventories under the Convention and the Kyoto Protocol

Astrid Olsson
Programme Officer
Reporting, data and analysis programme
UNFCCC

Parties to the United Nations Framework on Climate Change and the Kyoto Protocol have through several decisions of the Conference of the Parties and the Conference of the Parties serving as the Meeting of Parties agreed on a reporting framework for both developed and developing countries to report greenhouse gas emissions. For developed countries a review framework has been agreed. Developed countries have to report information on greenhouse gas inventories on an annual basis and their inventories are reviewed annually since 2004.

The presentation focuses on the reporting and review framework for developed countries. It provides information on the experience with the reporting and review framework under the Convention and the Kyoto Protocol. It touches upon the importance of collection of statistical data and their use in the preparation of a GHG inventory, including challenges linked to the use of statistics (quality and timing). In addition, the presentation provides an overview of reporting requirements for developing countries.

Role of Statistics Norway in estimating and disseminating information on greenhouse gas emissions, emphasizing the importance of national statistics as model input

Katherine Loe Hansen
Division for Environmental Statistics
Statistics Norway

A variety of institutional arrangements exists in countries compiling greenhouse gas inventories. This presentation describes the role of Statistics Norway in estimating and disseminating information on greenhouse gas emissions, emphasizing the importance of national statistics as model input.

In Norway, three core institutes collaborate closely, producing data on greenhouse emissions as reported to UNFCCC. Statistics Norway is responsible for compiling the greenhouse gas inventory and estimating emissions for all sources except land use and land use change and forestry (LULUCF), which are estimated by the Norwegian Forest and Landscape Institute. The Norwegian Pollution Control is appointed as the National Entity in Norway with overall responsibility for reporting to UNFCCC. National statistics like energy accounts and petroleum statistics are highly important in the emission inventory, as combustion of fossil fuels comprises about 70 per cent of the Norwegian emissions. Numerous other statistics provide input to less significant emission sources, but are nevertheless essential for the completeness of the inventory. The emission inventory compilers are benefiting from the long-term focus on statistical principles in Statistics Norway, and on being in the same institution as the compilers of input statistics as it greatly facilitates the flux of data and expertise.

Challenges of information support for calculation of greenhouse gas emissions

Dr. Konstantin Laykam
Deputy Head
Federal State Statistics Service (Rosstat)

Russia has own national system of greenhouse gas anthropogenic emissions system.

UNFCCC and Kyoto Protocol experts' reports on evaluation of Russian greenhouse gas anthropogenic emissions register confirmed that the country observes its national obligations in line with Kyoto Protocol.

Roshydromet is responsible of evaluation of the system`s functioning and provision of register and other required information in line with UNFCCC and Kyoto Protocol recommendations.

For an annual assessment of anthropogenic emissions from the sources and removals data from state statistical reports and other information on processes and activities that lead to anthropogenic emissions from the sources and greenhouse gas removals is used.

The Russian Federation has submitted to the Secretariat of the UNFCCC four National reports, national register and tables for 1990 - 2004 and a report on the amount of emissions.
Like other countries when building a register of anthropogenic emissions of greenhouse gases, using IPCC methodology, Russia faces with problems common to all countries. They are caused by differences in classification of activities and products used in the IPCC methodology and those used by the UN Statistics Division and Eurostat, as well as the lack of a list of products containing the fluorine element, which should be used in the collection of information on production, export - imports for the calculation of emissions of hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride.

Russia also faces internal problems related to the lack of detailed information on some of the indicators.

Roshydromet forms the list of information needed to build a register of greenhouse gas emissions, and in consultation with federal authorities submit to Rosstat proposals on improvement of national statistics.

GHG emission inventory – the case of Mauritius

Anand Sookun
Central Statistical Office
Mauritius
Santaram Mooloo
Ministry of Environment
Mauritius

- ✓ Country Profile
  - Geographical location
  - Socio-economic background
  - Environmental issues
- ✓ Climate change (CC) activities
  - Initial National Communication (INC)
  - Second National Comm. (SNC)
- ✓ Structure and institutionalization of CC activities,
- ✓ Meteorological Services (Director –National Project Coordinator), MoE, CSO, Others
  - ➢ 6 Team Leaders for the different working groups:
    1) GHG Inventory
    2) National Circumstances
    3) Vulnerability and Adaptation (V&A)
    4) Mitigation
    5) Projects and Policies
    6) Education. Training and Public Awareness
- ✓ Role of CSO in CC
- ✓ Structure of CSO
- ✓ Outline organigram
- ✓ Setting up of Environment and Energy Units
- ✓ Arrangement for hosting the Environment Statistics Unit within the line Ministry
- ✓ Setting up of GHG inventory compilation

- ✓ System in place for quality control, integrity and transparency to ensure reliability of estimates
- ✓ Stakeholders involved, comprising different sectors of the environment
- ✓ Steering committees
- ✓ Uses of the GHG inventory – SNC, MDG's,Env. Information System (EIS)
- ✓ Activity data for GHG inventory
    - Environment Statistics
    - Energy
    - Trade
    - Agriculture
    - Industry

SESSION 3: What is the role of official statistics in the measurement of the impacts of vulnerability and adaptation to climate change?

ABSTRACTS

Climate change and water: How water accounts can help our understanding

Peter Harper
Australian Bureau of Statistics

Climate change imposes potentially significant changes on meteorological and hydrological systems. To understand the impacts of climate change information about changes to these physical systems needs to be linked with information about human/economic activities and the broader environment. This paper explores possible ways that regular, comprehensive Water Accounts can inform our understanding of the implications of and the responses to changing water availability due to climate change. In particular, it describes some possible changes to water use by industries and sectors, as well as efficiency responses to expected increased scarcity and value of water resources. The paper incorporates results from a series of Water Accounts produced by the Australian Bureau of Statistics.

Regional Climate Change Scenarios for South America-The CREAS project

Jose A. Marengo
CPTEC/INPE
Rodovia Dutra km. 40, 12630-000 Cachoeira Paulista, São Paulo, Brazil
Tel +55 12 3186 8464, Fax +55 12 3101 2835
Email: marengo@cptec.inpe.br

The CREAS (*Regional Climate Change Scenarios for South America)* constitutes a regional effort aimed to provide high resolution climate change scenarios in South America for raising awareness among government and policy makers in assessing climate change impact, vulnerability and in designing adaptation measures. CREAS runs three regional models nested in HadAM3P (a GCM used in PRUDENCE): Eta for Climate Change Studies –Eta CCS, RegCM3 and HadRM3P. CREAS explores

issues such as: the challenge of using regional climate projections to develop plausible scenarios for future changes at daily time scales for extreme events; an assessment of current methods of scenario development for regions where data is available; assessments of vulnerability in regions and key sectors in South America.

Are central statistical offices prepared to track the impacts of climate change?

Robert Smith
Director/Directeur
Environment Accounts and Statistics Division/Division des comptes et de la statistique de l'environnement, Statistics Canada/Statistique Canada

robert.b.smith@statcan.ca

Central statistical agencies have been essential to tracking economic and social phenomena for the past 90 years. Over the past 30 years, they have developed some capacity for analysing environmental phenomena and linking them to the social and economic trends. Recently, statistical agencies have been improving their understanding and measurement of the linkages and consolidating these relationships in sets of environmental accounts.

Climate change has the potential to create a wide range of social and economic impacts. The paper will highlight (a) the range of expected biophysical, social and economic impacts due to climate change (b) and examine Statistics Canada's environmental accounts and other statistical and data frameworks to evaluate their ability to track these impacts. The paper will conclude with a discussion of what is missing and suggest priorities for filling perceived gaps.

Climate change policy making and the need for adequate statistical information with special regard to agricultural sector

Eva LACZKA (Hungarian Central Statistical Office) – Tibor FARAGO (Hungarian Ministryof Environment and Water)

Hungary has a 25-year of history and experience in the field of climate research. In the second half of the 80's the first climate impact monitoring emerged recording impacts of long term drought and other extreme climate phenomena.

The results of research have been integrated in the project "Global climate change: impacts and responses" initiated in 2003 by a co-operation of the Ministry of Environment and Water (MoEW) and the Hungarian Academy of Sciences (HAS). The National Climate Change Strategy (NCCS) elaborated by MoEW in 2007 is significantly based on the results of the previous research.

The comprehensive objective of the Strategy is to contribute to international initiations of trying to minimize the likelihood of global average temperature raise of 2-2.5 °C, furthermore to assist to the preparation of the environmental, social and economic systems to cope with the consequences of global warming.

Although the Hungarian Strategy covers the interaction between the climate change and the field of water management, crop production, animal breeding, forest and green areas, wildlife, human health and built environment, the Hungarian paper is going to focus on only the interaction between the climate change and crop production, animal breeding and forest and green areas in Hungary pointing out

- the impact of the above mentioned subjects on the climate change
- the impact of the climate change on the subjects in question
- challenges and solutions
- available and required data sources

Reviewing the tasks, it is obvious that for reaching the goals the strong co-operation between policy makers and statisticians is essential.

The Role of Official Statistics in the Measurement of the Impacts of Climate Change: Indian Experience

Sourav Chakrabortty
Social Statistics Division, Central Statistical Organisation
Ministry of Statistics & PI, Government of India, New Delhi, India

Climate is the long-term statistical expression of short-term weather which can be defined qualitatively as 'Expected Weather' or quantitatively by statistical expressions such as central tendencies and variances in key parameters. Changes in climate are the differences between the average conditions in terms of key parameters over time. There is broad consensus that major or minor climate change leads to many hazards and disasters via increased flood, land slides, avalanche and mud slide damage, increased soil erosion, increased flood run of, increased recharge floodplain aquifiers etc. It also causes displacement of people and increased deaths and serious illness in older age groups and urban poor, increased heat stress in life stock and wild life, increased risk of damage to a number of crops, decreased crop yields, decreased water resource quantity and quality, increased risk of forest fires etc. Relating such disaster like events to climate change can provide robust basis for assessing the impacts of such changes. These would require availability of sound database on the indicators of climate changes and occurrences of disaster type events.

In India different Ministries/Organisations/Institutions measures and monitors some indicators of climate changes but as such there is no regular information on climate change induced events such as flashfloods. Central Statistical Organisation in collaboration of National Institute of Disaster Management initiated a joint exercise to develop a Disaster Statistics database. This database will be one which can help researchers and policy makers to assess the impact of climate changes on major or minor disaster. The database will contain data of both hazards and disasters. Some of these hazards and disasters are manmade while most of them are due to change of climate over a considerable period of time. This paper will try to highlight the progress of this endeavour and also will try to explore the possibilities of measuring the impacts of climate change on hazards and disasters.

The analytical usefulness of a system of environmental accounts

Rutger Hoekstra, Sjoerd Schenau, Cor Graveland and Peter van de Ven
Statistics Netherlands

Economic activities have direct consequences for the pressures exerted on environmental systems. This paper will argue that the environmental accounting framework (SEEA, 2003) is particularly useful to assess the interrelationships between economy and environment. The environmental accounts have the advantage that they are consistent with national accounts.
Furthermore, they can be coupled to the framework of supply and use tables and input-output tables. This makes it possible to perform in-depth analyses. In this paper, among other things, we will illustrate the advantages and insights that can be obtained using data for CO_2- emissions for the period 1990-2005 for the Netherlands. Useful indicators, such as the ‘environmental balance of trade’, are calculated. Also other examples of the analytical usefulness of environmental accounts will be presented. The paper will conclude with a number of opportunities for increased international co-ordination as well as methodological and statistical improvements.

Macroeconomic modeling for energy and environmental analyses: Integrated economy-energy-environment models as efficient tools

Britta Bye
Statistics Norway

Integrated economy-energy-environment modeling has a long tradition in Norway. Early development of energy and environment statistics made it possible to develop computable multi-sectoral general equilibrium models (CGE models) with a rigorous description of energy supply and demand, and the inter-linkages between economic activity, energy production and use, and emissions to air. These integrated CGE-models have been used for forecasting purposes and numerous analyses of energy and environmental policy purposes during the last two decades. Especially the models have been developed to be suitable for analyzing different economic policy options to deal with the global climate issue as design of optimal carbon tax or carbon quota schemes.

Environmental pressures from German imports and exports - Results of Environmental-Economic Accounting on embodied energy, carbon dioxide and transport of goods

Walter Radermacher

In this paper first results of the German System of Environmental-Economic Accounting (SEEA) on the development of embodied environmental pressures of imports and exports are presented. The results on energy and carbon dioxide are based on a so called expanded hybrid IOT, which was tailor-made for the energy calculations. The causes of the development of embodied pressures are studied on basis of detailed results of the German SEEA by homogeneous branches of production. It is a main purpose of the study to investigate whether the variables included show a significant difference between the production and the consumption perspective in the CO_2-balance of nations. In addition the conclusions for reporting of official statistics in view of climate change are discussed.

Gearing A National Statistical System Towards the Measurement of the Impact of Climate Change: The Case of the Philippines[1]

Romulo A. Virola, Glenita V. Amoranto and Edward P. Lopez-Dee[2]

Concern for climate change has been gaining greater attention in the political agenda of most countries. Given its tropical climate, topography and geographic locale, high population density, poor socio-economic conditions and constantly evolving political environment, the Philippines is potentially vulnerable to the impact of climate change. A study by Greenpeace Southeast Asia claims that a one-meter sea-level rise, one of the effects of climate change, will affect 64 provinces of the Philippines, covering at least 703 municipalities3 and inundating almost 700 million square meters or 0.23 percent of the nation's total land area. Climate change, however, is not just an environmental issue since it has serious economic and social implications.

The alarming threat of the adverse effects of climate change in people's lives warrants a comprehensive strategic planning on the part of policy and decision makers. But planning can be truly effective only if it is based on high quality statistics. Unfortunately, environmental statistics and in particular, statistics on the impact of climate change are generally lacking both in terms of quantity and quality, particularly in developing countries. Part of the reason is that national statistical agencies have not been sufficiently involved in the generation of these statistics, not only because of resource constraints but also because of lack of subject matter expertise.

[1] Paper presented during the Conference on Climate Change and Official Statistics held in Oslo, Norway on 14-16 April 2008, sponsored by the United Nations Statistics Division, in collaboration with Eurostat and Statistics Norway.
[2] Secretary General, Statistical Coordination V and Statistical Coordination IV, respectively of the National Statistical Coordination Board (NSCB) of the Philippines. The NSCB is the highest policymaking and coordinating body on statistical matters in the Philippines.
[3] As of December 31, 2007, the Philippines had 1,494 municipalities and 136 cities.

In the Philippines, a number of studies and efforts on climate change have been initiated by both government and non-government organizations. In 1994, the Manila Observatory, an academe-based non-profit, non-stock organization, released an inventory of greenhouse gases by source. As a country party to the United Nations Framework Convention on Climate Change (UNFCCC)[4], the Philippines submitted its Initial National Communication to the UN body in 1999 containing a national inventory of anthropogenic emissions by source and removal by sinks of greenhouse gases and a description of steps taken or envisaged by the country to implement its commitment. The report also enumerated the sectoral issues and challenges related to the generation of data for the inventory. The government also created a Presidential Task Force on Climate Change (PTFCC) on 20 February 2007[5] that seeks to address and mitigate the impact of climate change in the country. Among the functions of the task force are to undertake/initiate strategic approaches and measures to prevent or reduce greenhouse gas emissions in the Philippines; design concrete risk reduction and mitigation measures and adaptations responses, especially short-term vulnerabilities, on sectors and areas where climate change will have the greatest impact; and, cause the integration and mainstreaming of climate risk management into the development policies, plans and programs of government. It is expected that statistical agencies and other government agencies will be involved in the generation of data pertaining to the task of the task force.

On the social impact of climate change, a paper by Greenpeace Southeast Asia in the Philippines entitled "Crisis or Opportunity: Climate Change Impacts and the Philippines", cited that the correlation study done on dengue and malaria by Amadore (2005)[6] showed that these two diseases were most sensitive to climate change as shown by the effect of temperature, relative humidity and rainfall on the incidence of these diseases. In fact, the several outbreaks of cholera, dengue, malaria and typhoid fever reported in 1998 (a La Niña year) has been attributed[7] to the extreme heat and water shortage brought by El Niño events.

---

[4] The **UNFCCC** or **FCCC** is an international environmental treaty produced at the Earth Summit in 1992 and took effect on 21 March 1994. The treaty is aimed at reducing emissions of greenhouse gases in order to combat global warming. The treaty as originally framed set no mandatory limits on greenhouse gas emissions for individual nations and contained no enforcement provisions; it is therefore considered legally non-binding. Rather, the treaty included provisions for updates (called "protocols") that would set mandatory emission limits. The principal update is the Kyoto Protocol, which has become much better known than the UNFCCC itself. It was adopted unanimously in 1997 and it finally entered into force on 16 February 2005.

One of its first achievements was to establish a national greenhouse gas inventory, as a count of greenhouse gas (GHG) emissions and removals. Accounts must be regularly submitted by signatories of the United Nations Framework Convention on Climate Change. ***Source:*** *UNFCCC website, http://unfccc.int., accessed date: March 3, 2008 and Wikipedia website, http://en.wikipedia.org/wiki/United_Nations_Framework_Convention_on_Climate_Change., accessed date: March 3, 2008.*

The Philippines aligned itself with more than 150 countries under the UNFCCCC process, signed the Convention on June 12, 1992 and ratified it on August 2, 1994. The Philippine Government likewise signed the Kyoto Protocol on 15 April 1998 and ratified it on 22 November 2001. ***Source:*** *Environmental Management Bureau, Department of Environment and Natural Resources website, http://www.cdmdna.emb.gov.ph. Accessed date: March 3, 2008.*

[5] Thru Administrative Order No. 171 signed by President Gloria M. Arroyo.

[6] **Amadore**, L.A. 2005. Economic and Social Impacts of Tropical Cyclones and the Warning System – the Philippine Situation, Quezon City.

[7] **Amadore**, L. A. 2005. Crisis or Opportunity: Climate change impacts and the Philippines. Greenpeace Southeast Asia.

Since 1995, the National Statistical Coordination Board (NSCB) has been generating environmental accounts for the Philippines.[8] And although the Philippines has yet to come up with a statistical framework and indicators system that will specifically link climate change with various social indicators, the necessary variables/statistics are officially available, for instance, environmental health statistics of the Department of Health (DOH) and human settlements data of the National Statistics Office (NSO). Indicators and statistics compiled by the NSCB through its Environment and Natural Resources Accounts (ENRA) and through the Philippine Framework for the Development of Environment Statistics (PFDES) would also be very useful. However, no attempt has been made as yet by the statistical offices to directly relate climate change with these available social variables and indicators.

Given the urgency of assessing the impact of climate change to society and the strategic role that the statistical offices can and should play in the process, the present lack of capacity of statistical offices and resource constraints should not be a deterrent for the Philippine Statistical System (PSS) to be able to generate statistics towards the measurement of the impact of climate change. Through the system of designated statistics[9], the PSS can move towards the regular and timely generation of climate change-related statistics. Continuous research and studies that would involve not only official statisticians but also experts from the academe and research institutions should be done to advance our understanding of the nature, causes and impact of climate change.

The development agenda of the Philippines is articulated in the Medium Term Philippine Development Plan (MTPDP), the information requirements for the implementation and monitoring of which are served by the Philippine Statistical Development Program (PSDP). As the statistical blueprint of the MTPDP, the PSDP is prepared thru interagency collaboration including representatives from both the public and private sectors and spearheaded by the National Statistical Coordination Board (NSCB). The PSDP addresses the information requirements of the MTPDP and lays the necessary framework for generating statistics and indicators needed by various stakeholders and data users, including those from the private sector. Thus, the PSDP serves as a mechanism for defining priority statistical programs and activities of the PSS in the medium term. Besides the PSDP, the NSCB has several mechanisms at its disposal to carry out this task. Among these are the sectoral Inter Agency Committees (IAC) e.g., the IAC-Environment and Natural Resources Statistics (IAC-ENRS) and the IAC on Health Statistics which are coordinated by the NSCB and composed of producers and users of statistics from government agencies, academe and non-government organizations. They can be used as a venue towards the resolution of statistical issues on climate change.

[8] The accounts cover 5 resources, namely, fishery, forest, minerals, land and soil and water resources and several economic activities like agriculture, fishery and forestry (Upland Palay Farming, Intensive Shrimp Aquaculture, Hog Raising and Logging of Diptercocarp and Pine Forest); manufacturing (Tuna Canning, Textile Industry, Leather Tanning, Paint Manufacturing, Cement Manufacturing and Petroleum Refining) mining (Small Scale Gold Mining; electricity generation; and, transport services (Land-based Transportation).

[9] The system of designated statistics was passed under Executive Order 352, Designation of Statistical Activities That will Generate Critical Data for Decision-Making of the Government and the Private Sector. It lists the statistical activities that will be undertaken, the designated agency of government, the frequency, level of diseggregation and time lag of the statistics to be generated.

This paper thus presents the mechanisms and structures that will be conducive to the involvement of the PSS in the measurement of the impact of climate change, with particular attention to the social impact. At the same time, it discusses the challenges facing the PSS in this direction. It also presents some statistics that are already available, both official and non-official.

Why Demographic Data are not Up to the Challenge of Measuring Climate Risks, and What to do about it

Susana Adamo
CIESIN
Columbia University

This paper identifies and proposes solutions to three challenges facing national statistical agencies that wish to help measure climate impacts, vulnerability and adaptation. (1) National census units are not well-delineated in geographic space, making it very difficult to locate human populations with respect to climate risks; this is especially problematic concerning coastlines and sea-level rise risks. (2) Inter-annual change in the spatial distribution of population is almost impossible to characterize with precision, because of incommensurate administrative boundaries across censuses. (3) Intra-annual variation in population distribution is not systematically tracked, making it hard to characterize exposure to highly variable climate risks.

Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

SESSION 4: Carbon emission trading and other mitigation strategies.

ABSTRACTS

Statistical office support for emission trading schemes: Developments in Australia

Peter Harper
Australian Bureau of Statistics

The Australian Government is establishing an emissions trading scheme. The design is scheduled to be completed in by the end of 2008, with the scheme expected to start in 2010. This paper explores how official statistics can be used to support emissions trading schemes, both in design and implementation. In Australia's case, a key role for official statistics is to provide Input-Output tables of improved quality and timeliness to support the economic modelling underlying the scheme. Emissions trading schemes also provide opportunities for new types of statistics and they have implications for the measurement of economic activity in particular sectors and for the nation as a whole.

China's National Climate Change Programme

XU Huaqing
Energy Research Institute
National Development and Reform Commission, China
B-1405, Guohong Building, Muxidibeili, Beijing 100038, China
Tel: 0086-10-63908455; Fax: 0086-10-63908457
Email: xuhuaqing@amr.gov.cn

As a developing country of responsibility, China has taken a series of policies and measures to address climate change in the overall context of national sustainable development strategy. In June 2007, the Government of China issued *China's National Climate Change Programme,* outlining objectives, key areas of actions, as well as policies and measures to address climate change for the period up to 2010. This presentation will focus on polices and measures related to mitigation under the programme. It will also discuss the role of official statistics in the development of national strategies on climate change.

Integrated Environmental and Economic Accounts for Tradable Carbon Dioxide Emission Permits

Thomas Olsen
Statistics Denmark

The European Emissions Trading Scheme, which is part of the global carbon dioxide (CO_2) emission allowance market, constitutes a complex market for CO_2 permits.

In this paper, the Environmental-Economic Accounting framework is introduced as a tool for analyzing both the physical and the monetary aspects of the permits as well as the permits flow through the economy.

Overall, the Environmental-Economic Accounting framework enables the user to make consistent analyses of the economic activity, consumption of energy, air emissions and the flow of CO_2 permits.

Monitoring climate change mitigation in the context of national sustainable development strategies

Matthias Bruckner (United Nations Department of Economic Affairs, Division for Sustainable Development)

Both developing and developed countries address climate change mitigation and, to a lesser extent, adaptation in their national sustainable development strategies (NSDS). This allows countries to recognize and adequately value co-benefits of policy measures and to identify and appropriately address potential trade-offs. Moreover, for developing countries, the Bali Action Plan explicitly states that mitigation action should be in the context of sustainable development. The presentation discusses the overall monitoring requirements for the implementation of climate change related polices and measures described in NSDS as well as current country practices in this regard.

Martin Nesbit
Department of Environment, Food and Rural Affairs
United Kingdom

The use of climate change statistics to inform national policy on mitigation: UK climate change programme

UK policy on emissions is set out in a comprehensive **Climate Change Programme**. Current **legislation** before Parliament sets out new high-level process for managing UK emissions.

UK **inventory methods are robust**, and comply with IPCC guidance. However, p**olitical focus**, and **high profile targets**, put the data and targets under **intense political scrutiny**.

Policy makers therefore need a **clear understanding of the basis** of inventory and other data; and need to promote informed public debate.

Particular issues relevant to the policy debate in the UK include:

- Treatment of emissions from **international aviation**
- Embedded emissions from **net UK imports** of carbon-intensive goods
- Potential in some sectors (e.g. **agriculture**) for policies aimed at reducing inventory record of GHG emissions to be counter-productive

Understanding of data needs relating to the **economic impacts** of mitigation options needs to be improved.

SESSION 5: How can official statistics support climate change scenario development and modelling and better inform the IPCC's Fifth Assessment Report?

ABSTRACTS

How might Official Statistics assist with the Fifth Assessment Round of the IPCC?

Dennis Trewin

The climate projections of the IPCC are largely shaped by a range of scenarios for the future. The key variables describing these scenarios are used in climate change models to estimate projected changes in temperature, etc. These variables include items where official statistics can inform such as population projections, economic growth, the extent of convergence between the relative size of economies on a per capita basis, and the level of intensity of use of fossil based fuels. A new set of scenarios is likely to be developed in the Fifth Assessment Round.

The paper will describe the availability of relevant official statistics. It will suggest that a baseline scenario be based on the best estimates from authoritative data sources and the use of the application of sound statistical methods.

SESSION 6: Bringing it all together: Classifications, standards and frameworks for climate change statistics. Do indicator systems play a role? Are existing frameworks adequate? Do they need to be amended or extended? What needs to be done to ensure these frameworks can be applied by National Statistical Offices?

ABSTRACTS

The role of Spatial Data Infrastructure in Integrating Climate Change Information with a focus on Monitoring Observed Climate Impacts

Susana Adamo
CIESIN
Columbia University

This presentation explains how observed climate change impacts are identified using the methodology of the IPCC's Fourth Assessment (1) as an illustration of how integrated spatial data infrastructures are essential for identifying such impacts systematically. The strengths and weaknesses of the IPCC methodology are assessed including the challenges experienced identifying impacts in developing countries. Recommendations for how such an approach can be adapted for national use are offered, focusing on spatial data infrastructure requirements.

What role for official statistics: provider of statistical services for a specific use, or more?

Heinrich Bruengger
Director
Statistics Division
Economic Commission for Europe

Results of official statistics are meant to be authoritative from two points of view:
a) the quality of the data used in terms of “fitness for use”
b) the conceptual adequacy of the definitions and classifications as being able to reflect adequately and impartially a societal phenomenon for a wide

community of users and a variety of uses.

In most cases, conceptual adequacy is obtained through national official statistics, as well as international producers, being in line with international standards of official statistics.

Another function of both national and international producers of official statistics is the provision of statistical services for individual users and specific uses, using data available in the system (in the case of national producers), or obtained from countries (in the case of international organizations). In this case, the guarantee function of official statistics only covers the quality of the data; the conceptual adequacy is defined by one single user, or for one specific use, outside the mechanisms of official statistics.

Until now, the work in official statistics for the issue of climate change has been predominantly of the second type, i.e. statistical services for concepts defined outside the mechanisms of official statistics. It is clear that such services should continue as part of the functions of statistical systems, but should this function remain the only one for official statistics in the context of climate change? The paper examines the potential, as well as the limits, of either using existing statistical standards from other subject areas, or developing new standards and guidelines, for the measurement of climate change in the framework of international official statistics.

Spatial Data Infrastructure: A framework for Climate Change Statistics

Gilberto Calvillo-Vives
President of INEGI, México

Climate change is better understood considering earth as a complex system whose components are several “spheres”. The traditional ones, Atmosphere, hydrosphere, lithosphere and biosphere, plus two other that are specially relevant for climate change: Anthrop-sphere an exosphere. The first one deals with human activities that impact the environment and the later deals with the solar system; mainly with the Sun as source of cost of the energy that sustains life on earth. Except for the exosphere, all spheres are subsystem of the complex system Earth. In fact exosphere is a system that contains Earth as an open subsystem which receives a constant flow of solar energy.

A multitude of processes take place on system Earth. Among them the ones that are directly responsible for climate change. These processes can be classified in two categories: The ones that have been evolving since the origin of the planet and those of anthropogenic nature. For a long period human activity on earth have a negligible impact on the environment. However in recent history, population explosion and industrial development did affect the natural processes, as shown by different studies.
The dynamics of System Earth is determined by the processes that take place in each one of the “spheres” but also among them. The information to describe the state of the system comes, at great extent, from the geographical sciences. To deal with the big number of information producers and the huge amount of data involved in the description of territory and its features geographers have developed the concept of

Spatial Data Infrastructure (SDI) which is a systemic approach to the gathering, organization, dissemination and use of geographical information

The present concern for the environment has prompted United Nations and some other parties to promote actions to mitigate environment deterioration which leads to global warming. In order to asses the effectiveness of the actions taken, it is important to understand the dynamics of the system Earth and to be able to measure some of the more relevant variables in the processes. Increment of greenhouse gases is only one among many other. The general framework to deal with the statistical characterization of system Earth, its state and the assessment of the actions taken is the so called Pressure – State – Response (PSR) model.

In Mexico official statistical and geographical data is produced by the National System of Statistical and Geographical Information (NSSGI). The system is organized in three subsystems: the one in charge of demographic and social information, the one that deals with economic information and the one that deals with geography and the environment. This last subsystem uses as frameworks the spatial Data Infrastructure for geography and the PSR model to address environmental problems.

In this talk we will show how the SDI is being constructed and how it naturally can encompass the indicators used in the PSR model. Also, some examples about the use of this SDI will be presented.

The climate challenge - implications for sectoral statistics

Viveka Palm
Statistics Sweden

In order to make good policy and analysis in the climate change area, there is a need for well integrated official statistics. This paper outlines some of the experiences of the integration of sectoral statistics in Sweden, and what challenges lies ahead.

Data of relevance for climate change cover many areas, some of which are more suitable for statistical reporting than others. Concerning data on the *state* of environment, the information available is largely based on research projects and on modelling. For the statistics that concern groups of *actors* (governments, industries, households*)* in society and their environmental performance, there are promising methods to use, that are appropriate for the clime change assessments. Integrating statistics for the climate change area can be a role model for integrating statistics in general, and produce more relevant and up-to-date information.

What type of new statistics are required? More information on the costs for adaptation e.g. against flooding and more extreme weather events is likely to be needed. The need for data to assess the new market-based environmental economic instruments is also widely recognized.

What changes are needed to existing statistics? The existing statistics classifications can be developed to increase the usability of the data for new types of analysis. The availability of the data both nationally and internationally can also be improved upon. More in-house analysis is also recommended.

Getting indicators established, a UK experience

Stephen Hall
DEFRA
United Kingdom

The UK has over ten years of experience in establishing sustainable development indicators. In 2005 a third generation of indicators was released, building on lessons learned from earlier sets of indicators. The UK experience includes stakeholder consultation, cross-Government dialogue and cooperation, data development and management, pragmatism and above all effective communication. The UK's sustainable development indicators have been predominantly policy driven in that there is not an explicit theoretical underpinning framework. Instead the choice of and need for indicators has been determined by the frameworks inherent within policy thinking, including indicators supporting climate change policy.

Climate Change and Indicators of Sustainable Development

Matthias Bruckner (United Nations Department of Economic Affairs, Division for Sustainable Development)

Indicators of sustainable development can provide a useful framework for climate change statistics, as they allow placing it in the broader sustainable development context. The recently revised Indicators of Sustainable Development coordinated by the United Nations Division for Sustainable Development contains a number of climate change specific indicators as well as indicators addressing important linkages between climate change and other sustainable development issues. The climate change related Indicators of Sustainable Development will be presented, their statistical requirements will be discussed and areas that require intensive additional work will be identified.

The System of Environmental-Economic Accounting and its contribution to Climate Change

Alessandra Alfieri
United Nations Statistics Division

Sustainable development policies addressing the challenges of climate change must be based on a sound statistical information system. An important part of this is the System of National Accounts (SNA) that renders a framework for comprehensive time series of data, tables and accounts to analyze fiscal, price and monetary instruments and regulations for jobs, growth and productivity. In relation to economic-environmental dimension of sustainable development and climate change the *System of Environmental-Economic Accounting* (SEEA) is an important extension of SNA, which brings together economic and environmental information in an integrated framework by using standard concepts, definitions and classifications. This framework links the physical and monetary information on flows and stocks of natural resources and ecosystems to conventional national accounts thus providing policy-makers with coherent time series of data, policy indicators and descriptive statistics for scenario modeling to analyze, plan and monitor the sustainability of growth.

The paper/presentation argues that the SEEA, which is expected to be adopted as an international statistical standard for official statistics in environmental-economic accounting by the United Nations Statistical Commission – the apex entity of the global statistical system – is an essential statistical framework for climate change policies. The SEEA, by presenting the main categories of emissions by sources and removals by sinks (i.e. energy, industrial processes and product use, agriculture, forestry and other land use, waste, etc.) in an integrated framework linking the economy and the environment, offers the analytical framework to evaluate how economic activities create pressures on the climate, and how climate change affects both the economy and the environment.

The paper/presentation goes on to show that by supplementing national emission inventories and UNFCCC reporting schemes with the SEEA considerable additional value added is obtained by allowing for the analysis of the impact of policy interventions (e.g. emission permits, taxes, subsidies, financing, etc.) on present and future emissions and on other environmental pressures as a result of changed patterns of production, consumption and accumulation. More specifically, the application of SEEA will offer a more detailed and comprehensive evaluation of the tradeoffs between mitigation and adaptation policies, technology and their financing, their impacts and effectiveness.

Finally, the paper/presentation proposes a research agenda to be addressed through close cooperation between national and international experts on climate change and environmental accountants and statisticians. The agenda would include:

(a) Identifying and analyzing conceptual issues (for example, harmonization of industry and product classifications to facilitate the technology and industry conversion, adaptations of environmental protection expenditures classifications to analyze expenditures on mitigation and adaptation; the link between UNFCCC reporting and

SEEA emission accounts; elaboration on the classification of sinks and wastes to reflect the removals by sinks (e.g. linking forest accounts to carbon binding);

(b) Reviewing the statistical coordination to enhance statistical quality and cost effectiveness at national and international level (for example, streamlining data items and reporting practices for the UNFCC reporting and the SEEA, the use of additional checks and balances and comparing data from different systems,);

(c) Promoting the use of official statistics for climate change policies.

Session 1 : Conference papers

UN Conference on Climate Change and Official Statistics

Presentation by Professor Jacqueline McGlade
Executive Director, European Environment Agency

"Why we need better statistics for climate change policies"

Oslo, 14 April 2008

Introductory remarks …

Ladies and gentlemen,

The Bali conference on climate change last December started a process towards a future global agreement on the arrangements for mitigation and potentially for adaptation in the coming years. Everyone I am sure is hoping that it will be successfully completed in 2009 in Copenhagen and that it will not only bring governments closer together on what needs to be done in the future, but also create an clear link to actions that need to be taken by citizens around the world.

The Intergovernmental Panel on Climate Change (IPCC) has shown that global greenhouse gas emission reductions of about 50 % by the middle of the century are needed to limit the global temperature increase to a maximum of 2 °C (which is the EU target). However the IPCC also showed that even with an ambitious global mitigation programme there will still be substantial climate change impacts that we will have to adapt to.

Thanks to the Kyoto Protocol's emission reduction commitments, the information needs for mitigation policies are relatively well understood. Monitoring the effectiveness of current and new policies for key emitting sectors, such as the energy and transport sectors, is addressed by a well established annual collection and reporting process of data on greenhouse gas emissions according to agreed international IPCC guidelines. But, as I will discuss later, new challenges and improvements lie ahead.

With respect to adaptation, data needs are far less clear: policy targets are much more difficult to define and less well established and measures have only recently started to be implemented, often also for other reasons than adaptation. In Europe, many of today's adaptation activities are focussed on flood management and defence, with measures relating to drought and water scarcity now under development. Climate change adaptation is also insufficiently embedded in the development of the policy arenas that will be most affected, such as biodiversity and nature protection, agriculture and forestry, energy, tourism, health, navigation and infrastructural developments. There is a great and pressing need for new data and for improvement of currently available data, in particular establishing benchmarks for the effectiveness of different adaptation strategies and calculating the costs of inaction and action. I will come back to this point later.

Greenhouse gas emission data: more timely and more spatial detail needed

Countries have for many years collected and provided data on past greenhouse gas emissions and also on projections to the UN Framework Convention on Climate Change. These data apply within the national boundaries of the countries, although emission data from the rapidly increasing international aviation and maritime sectors are also included as memo items.

The emission estimates build on statistics for the main emitting sectors, in particular energy production and use, industry, transport, agriculture, land use and forestry. These underlying statistical data are provided by statistical institutes. Given the important economic implications it is very important that the data are delivered in a timely fashion and with high quality to inventory compilers. This is especially relevant for energy statistics, since this sector is responsible for 80% of the emissions in many countries. In the EU recently, an Energy Statistics Regulation has been adopted which hopefully will result in faster availability of more complete energy data. Statistical institutes thus have an important role, together with GHG inventory compilers, in the National Inventory Systems that are in place in all countries that ratified the Kyoto Protocol.

EEA monitors progress in reducing total greenhouse gas emissions based on information provided by our 32 member countries. There is a specific focus on EU15 due to their “target sharing” under the Kyoto protocol – namely a reduction of -8% by 2008-2012 from 1990 levels.

Our next inventory report, including preliminary data for the year 2006 will be published later this month. Final data will be published in June. This highlights an important issue: even with enhanced efforts on timeliness of all underlying statistics, annual emission data can only be published about 1.5 years after the year in question. This means that we will not know until 2014 if we have met our Kyoto commitments in the period 2008-12.

This is not good enough, especially given the high profile currently enjoyed by climate change. Policymakers obviously need more timely data. So the EEA –together with the member countries - has started a project to estimate data for the preceding year after about 6 months, to be reported for the first time in 2009. Hopefully, national statistical institutes will work closely together with inventory compilers to prepare such preliminary Year-1 estimates.

Let me add that many cities and regions in Europe are starting to set their own GHG emission targets on a more voluntary basis. There is therefore an increasing need for more spatially detailed emission data, e.g. by city or by region. These are not yet available and will require efforts by statistical institutes to have the underlying data available at the right level of spatial detail. This work can fit well with increasing attention to urban statistics in general.

Greenhouse gas emission data: need for transparency

Recently NAMEA (national accounting matrices including environmental accounts) estimates have emerged combining GHG emission inventory data with national economic accounts. NAMEA measures emissions caused by a country's residents and businesses also within other countries and discounts emissions caused by foreign visitors and businesses to the country. NAMEA results in different national total emissions than UNFCCC GHG inventories. This can cause confusion for policymakers and the public since the differences are difficult to explain. NAMEA figures are sometimes presented as being 'more accurate', thus bringing the credibility of the UNFCCC inventory system into question. This is problematic because the inventory system is closely linked to the current allocation of responsibility for reducing GHG emissions under the

Kyoto Protocol which is to individual countries. Until 2012 the inventory system is not expected to be changed. NAMEA can be a useful tool to understand GHG emissions from production and consumption in society both inside the country and also outside, but much care should be taken in presenting and interpreting NAMEA GHG emission estimates.

EU Emission Trading Scheme (ETS) is changing data needs

The EU ETS covers about 40% of total EU GHG emissions. It covers all major emitters of CO2 from industry (such as power and heat generation and steel production). The annual emission data from 2005 onwards are available for all major individual installations in the EU (about 11.000 installations), through the Community Independent Transaction Log. EEA last week provided selected EU ETS emission data sets on its web site together with an analytical tool to analyse the data.

Policymakers are increasingly using ETS data and will do so even more in the near future to analyse trends and progress towards the new 2008-2012 caps for the trading sector of each EU Member State. Currently proposals for a revised and more harmonised EU ETS for the period after 2012 are being discussed. The trading sector will have an overall EU reduction target with allocation of allowances to installations in a more harmonised way. It is expected that the revised EU ETS will be adopted soon and will require further transparent and detailed reporting and monitoring.

Collection and quality checking of EU ETS data is done by the competent authorities, linked to the permitting process, with verification done by independent verifiers. The market is setting the price for carbon, giving an indication of the costs of measures to reduce emissions.

Although statistical institutes are not directly involved they can play a role for example in providing additional economic sectoral data to help analyse cost-effective measures.

Need for data on Kyoto mechanism projects

Countries can of course also use Kyoto mechanisms to reach their Kyoto targets for 2008-2012. The number of CDM (Clean Development Mechanism) projects with developing countries has increased enormously the past few years. CDM projects are approved by the UNFCCC CDM Executive Board. Various organisations maintain data on CDM projects, including the UNFCCC secretariat. In 2009 information on Kyoto credits will be available in countries' Kyoto registries which will be reported to the UNFCCC. This is crucial information to determine to what extent countries are on track to their targets, and we will include this in our analyses.

So far statistical institutes have not really been involved, but they should explore the needs and possibilities for a future involvement, even though the sums of money involved may not at this stage be significant in terms of overall European economy.

Vulnerability and adaptation data needs

Climate change affects biodiversity and nature protection, water resources and quality, agriculture and forestry, energy, tourism, health, navigation and infrastructural developments. To assess such impacts, data is needed on the current climate and on projected climate change for the next decades up to 100 years. Regional climate downscaling at detailed spatial levels, e.g. even below 50x50 km, is becoming available but still has large uncertainties. Temperature can be better projected than precipitation. Projections for frequency and intensity of extreme weather events are particularly uncertain. Projections of the hydrological cycle are needed as well, to better address droughts.

Vulnerability assessments combine projected climate change with changes in natural and socio-economic systems and have been performed for many countries across the world, including the EU, but also for developing countries as part of National Adaptation Plans of Actions (NAPAs).

Within the UNFCCC, the Nairobi work programme is being implemented to help countries improve their understanding of climate change impacts and vulnerability in order to increase their ability to make informed decisions on how to adapt successfully.

There are also ongoing discussions about new additional adaptation funding mechanisms beyond the currently agreed funds (like the Adaptation Fund to be financed with a share of proceeds from CDM projects) to support developing countries meet the increasing needs to act. These activities will need to be underpinned by a mixture of models and statistics, to enable countries get the most benefit out of such new funding.

Along the same lines, the European Commission's own Green Paper on adaptation, published in 2007, identified the need within the EU for enhancing the knowledge base, but also identified possibilities for early action is some policy areas. For example the EU Water Framework Directive is well-suited to address climate change adaptation through its step-wise and cyclical approach, but its success in this area will depend on the extent to which a longer-term perspective is included in the river basin management plans. Other key environmental policies in which integration of climate change adaptation is important are the Marine Strategy Directive and the Directive on Assessment and Management of Floods.

But in addition more local risk based analyses aimed at improving resilience in natural and human systems are essential. This should increase resilience also to the current climate extremes.

Both vulnerability and risk based local approaches require better seasonal data, for example in agriculture and forestry accounts and in the water sector, and operational forecasts, for example from the GMES (Global Monitoring for Environment and Security) fast track services. These will require new geo-spatial statistics and indicators across scales, for example water balances at river basin level, and for ecosystem functional units and services, as well as relevant socio-economic statistics.

The recently adopted EU Inspire Directive on the provision of spatial environmental information will help provide some of the necessary data from the geophysical and natural domain.

But there is a great deal of interest in deriving more information on practical adaptation measures and costs of adaptation, including methodologies and data are needed on cost-effective measures.

Statistical offices can thus help these global, regional and local efforts by improving the required basic data and corresponding frameworks such as environmental accounting.

How ecosystem accounting can help climate change vulnerability assessments

I had the opportunity to speak at the high-level EU conference organised a few months ago on 'Beyond GDP' –those of you present there would remember that the recognition of the services that the earth's ecosystems provide to societies is now firmly enshrined in socio-economic considerations. The UN decision to update the Millennium ecosystem assessment and the G8+5 decision to call for a Stern-like report on biodiversity are two recent important political commitments that will help further progress in this direction. The impacts of and the adaptation to climate change prominently feature in this context.

Ecosystem services indeed include provisioning services such as food, water and timber; regulating services that affect climate, water, soil, waste and disease; cultural services that provide recreational and spiritual benefits. The value for people's well being of ecosystem services is accounted only when these services are incorporated into the price of products. When their market price is zero, however, as in many cases at present, for the market they simply don't exist, whatever their importance. They can be accordingly appropriated for production or simply degraded without any recording. These free ecosystem services should be measured, and computed in a more inclusive aggregate, called Inclusive Domestic Product.

The negative impacts on ecosystem services of, for example, over harvesting, deforestation, fragmentation by dams, acidification of oceans and sealing of soil, will be enhanced by climate change. They have no direct counterpart in GDP. This means that the full cost of producing and consuming domestic goods and services are not covered in many cases by their market price. Allowances should be made for these ignored costs and added to the current production output and imports of countries, sectors and companies for computing the full cost of domestic and imported goods and services.

These two aggregates, including also impacts of climate change where feasible, can provide added-value to policy makers and supplement GDP, but not replacing or adjusting it.

The two aggregates are based on environmental accounting for ecosystems. These ecosystem accounts can be established in both physical and monetary terms. Environmental accounting is a joint activity between EEA, Eurostat and member countries in the context of the European Strategy on Environmental Accounting and the revision of the UNSEEA2003, prior to adopting an international UN standard by 2010.

There is no doubt that environmental accounts, in particular land and ecosystem accounts, will provide the necessary complement to the further modelling of climate change vulnerability and adaptation processes. It offers a coherent, multi-scale and integrated analytical framework for improving our knowledge base on their distribution, dynamics and resilience potentials over space and time, as well as on their economic relevance through established valuation and benefit transfers techniques. The EEA, together with its partners, is committed to make this happen.

Conclusions

Colleagues, let me now conclude with the following remarks:

- Climate change is the biggest challenge facing mankind at the present time
- The statistical system can support climate change mitigation policies by providing timely statistics with high quality for national GHG inventories.
- New data demands are coming from the EU emission trading scheme and from use of Kyoto mechanisms in particular the clean development mechanism.
- For climate change impacts, vulnerability and adaptation policies strategies and policies are emerging and new data with more details in time and space will be needed.
- Improvement of climate change data to inform policymakers requires a joint effort by environmental agencies and statistical institutes as well as businesses and the research community at national, European and global level.
- EEA is committed to work together with Eurostat and our member countries to strengthen the links between environment and economic statistics
- I therefore strongly welcome this initiative by the UN, Eurostat and the World Bank to bring statistical institutes together to discuss, clarify and strengthen their role in the overall framework.

SETTING THE SCOPE:
UNDERSTANDING THE DEMAND FOR STATISTICS CREATED BY THE SCIENTIFIC AND POLICY FRAMEWORK OF CLIMATE CHANGE AND THE ROLE OF OFFICIAL STATISTICS IN SATISFYING THIS DEMAND

NOTES FOR REMARKS BY

ALEX MANSON
SPECIAL ADVISOR ON CLIMATE CHANGE POLICY
ENVIRONMENT CANADA

UNITED NATIONS' CONFERENCE ON CLIMATE CHANGE AND OFFICIAL STATISTICS

OSLO, NORWAY
APRIL 14, 2008

Climate change is perhaps the biggest environmental threat that we face today, one that affects all of us, as individuals, as national economies and as citizens of the global community.

Scientific evidence clearly indicates that there will be serious consequences if concerted action is not taken to significantly reduce global greenhouse gas emissions.

This morning I want to talk about the fundamental elements of both domestic and international policy frameworks for addressing climate change and suggest some areas where you as official statistics experts might want to discuss what you could do to help formulate effective policies and to help report on progress in their implementation.

Climate change is a deceptive problem.

On the one hand, it appears to be quite straightforward.

Globally, about 60 percent of greenhouse gas emissions are carbon dioxide come from energy production and use, 14% are methane emissions from agriculture, waste and energy, 8 percent are nitrous oxide from agriculture and other sources, 3 percent are carbon dioxide from other sources, about 1 percent are fluorinated gases and 17 percent are carbon dioxide from deforestation and other decay.

In industrialized countries, while precise proportions vary from country to country, energy production and use is generally responsible for about 80 percent of total greenhouse gas emissions.

Two fundamental actions are required to reduce greenhouse gas emissions associated with energy production and use – the energy intensity of our economic activity must improve on a continuous basis and we must reduce the carbon content or decarbonize the energy that we use on a continually improving basis.

Making progress on these two fundamentals essentially comes down to three strategies – improving energy efficiency, switching the energy sources and fuels that we use, and capturing and permanently storing carbon dioxide from fuel combustion before it is emitted into the atmosphere.

The relative importance of each of these strategies will vary from country to country. For Canada, for instance, over the long term, switching energy and fuel sources and carbon capture and storage will likely each be the source of about 40 percent of our emissions reductions while energy efficiency improvements will likely be responsible for about 20 percent. In other countries, the relative importance of the three strategies may be quite different.

Through this lens it looks like climate change policy frameworks should be relatively straight forward with well defined and achievable end-states.

Let's look at climate change through another lens.

Energy is essential for economic growth and social development. Over the coming decades this fact will lead to a surge in energy demand. If the current trend continues, fossil fuels will provide most of the planets energy leading to a considerable rise in greenhouse gas emissions.

Reducing global emissions over the long term will require a complete transformation in the capital stock of energy producing and consuming businesses and households as well as engagement of consumers to effect major changes in consumption patterns. The broad deployment of existing and near-commercial technologies will play a central role. New low- or zero-emissions technology will also be required.

Further warming of the global climate and some associated impacts are already unavoidable. Adaptation can reduce vulnerability and is inextricably linked to sustainable development. Existing and new technologies will also play an important role in facilitating adaptation to a changing climate.

Looking through this lens, climate change is a very complex problem that involves most of the imperfectly understood systems in our societies.

Solutions that will result in real progress over the long term demand profound understanding of how the causes and effects of climate change are integrated into our social systems and their on-going development.

Progress in reducing greenhouse gas emissions will only come through a stepwise approach that sets countries on a long term path to deep emission reductions through incremental improvements continuing year over year. Such an approach requires a steady signal and a clear path forward for industry and consumers, facilitating innovation, new investment, and changed behaviour.

In order to better understand how to make these transitions over the long term so that risks are minimized, there are important information needs.

Let me outline a few from my perspective but I leave it to you to consider the roles official statistics should play. These include:

- standard macroeconomic forecasts for use in modelling work for comparative purposes;
- technology cost curves to project effective deployment of low and non-emitting technologies;
- comparison of low and non-emitting technology experience curves with other large-scale technology development and deployment experiences to better understand barriers;

- emission reduction cost curves for key economic sectors and technologies that offer high potential;
- how research and development can be expected to lower the cost of new low and non-emitting technologies;
- energy use in energy production and distribution systems;
- energy expenditures; and,
- how to build resilience to a changing climate into all the day-to-day dimensions of our societies and our economies.

Emission reduction commitments under the current international agreement guiding global actions on climate change – the Kyoto Protocol – expire in 2012.

The United Nations Framework Convention on Climate Change has been widely endorsed as the appropriate forum for the development of a new post 2012 international agreement and intensive negotiations are underway.

At the December 2007 meeting in Bali, Parties agreed to the Bali Action Plan with a view to concluding a new agreement by the end of 2009.

Discussions on elements of a new agreement are also taking place in key multi-lateral fora including the Major Economies Process, the G8, and the Asia-Pacific Economic Co-operation.

A number of principles have been proposed for a workable post-2012 climate change agreement. These include:

- Balancing environmental protection and economic prosperity, being economically realistic, and not unduly burdening the growth of any single country;
- Setting a target date for stabilizing global emissions and setting a goal of at least cutting global emission in half by 2050;

- Contributions from all major emitters – while major developing economies can obviously not be expected to make the same kind of contributions as developed countries; the science clearly demonstrates that they must be part of the solution;
- Support for the development and deployment of new and better technologies - institutional mechanisms, measures to improve the enabling environment for private sector investment, as well as direct funding initiatives to aid broad-based technology transfer will be required to support a transformation of global capital stock over the next 50 years;
- Flexibility so that all countries can choose the tools and policies that suit their unique circumstances as well as accommodating a variety of commitments as well as multi-stage efforts by countries and countries being able to agree on specific targets for emissions reductions from highly globalized industries such as cement and fertilizers;
- Mechanisms to promote reduced emissions through reductions in deforestation - as mentioned earlier, deforestation is responsible for almost 20 percent of global greenhouse gas emissions; and,

- Support adaptation to a changing climate.

A new international climate change agreement is going to have to be very robust – it will have a lot of weight to lift. A 50 percent reduction in the global greenhouse gases that were emitted in 2000 amount to something of the order of 18 gigatonnes if emissions from deforestation are excluded . That's more than the total emissions of the EU 27, the United States and China in 2000. And 18 gigatonnes of reductions from 2000 levels does not include offsetting all of the emissions growth that is anticipated under business-as-usual projections. And global reductions beyond 50 per cent may be required.

Reducing the energy intensity of the global economy and the carbon intensity of energy and fuels that will be essential will require the broad deployment of all low and non-emitting technologies that are currently available as well as major breakthroughs in energy efficiency including in the transportation sector, renewable energy, next generation nuclear, clean coal technologies and carbon capture and storage.

Again let me outline a few areas where official statistics could play a role in the international policy framework. These include:

- comparable structural definitions for key economic sectors so comparisons can be made;
- consistency and comparability in defining technology characteristics;
- bringing down the costs of new low and non-emitting technologies; and,
- improving estimates of business-as-usual improvements in energy efficiency of economic development and improvements in carbon intensity of energy production and use.

Official statistics will also have a role to play in implementing the Bali Action Plan.

The Bali Action Plan will require statistical analysis to backstop the agreed upon

- "Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity building in a measurable, reportable and verifiable manner", and
- "Measurable, reportable and verifiable nationally appropriate mitigation commitments or actions, including quantified emission limitation and reduction objectives by all developed country Parties while ensuring the comparability of efforts among them, taking into account differences in their national circumstances".

Deep reductions in global emissions of greenhouse gases means transition on many levels – transitions in policies, transitions in technologies, transitions in economies and transitions in societies. Official statistics will have important roles to play helping ensure these transitions are efficient and effective and in reporting on their progress.

Thank you

Data needs for addressing Climate Change – UNEP's perspective

UNEP/DEWA scoping paper
UNSD/Statistics Norway Conference on Climate Change & Official Statistics,
Oslo, 14-16 April 2008

1. Introduction: Climate Change tops the environmental policy agenda

Earlier this year, in February 2008, the UN Secretary-General Ban Ki-moon addressed the UN General Assembly in a High-Level Thematic Debate ("Addressing Climate Change: the United Nations and the world at work"), saying:

"We have moved climate change up to top of the agenda, where it belongs…. The United Nations is called on to ensure we can implement existing mandates, as well as future ones. Every part of the UN system is committed to supporting Member States as an effective, inclusive and credible partner in mitigating and adapting to climate change". This momentum was generated in large part by the IPCC, which made clear that climate change is already happening and accelerating. UNDP's Human Development Report highlighted the devastating effects climate change is already having on the poorest and most vulnerable, making the achievement of the Millennium Development Goals more challenging. UNEP's flagship GEO-4 report concludes that adaptation to climate change is now a global priority, and calls for improved monitoring and enhancing our scientific understanding of the potential tipping points beyond which reversibility is not assured.

2. UNEP & the issue of Climate Change

With the release of the IPCC Fourth Assessment Report and the Bali Action Plan adopted by UNFCCC COP13, UNEP finalized its Medium Term Strategy (MTS) with six thematic priorities topped by Climate Change. Several other priority areas are very much related to climate change, such as ecosystem management, disasters and conflict, and environmental governance. Related to Climate Change, four themes were identified: adaptation, mitigation, science and communication.

UNEP's mandate to address climate change issues flows from its role as "*the leading global environmental authority that sets the global environmental agenda and one that promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system*" (from the Nairobi Declaration). For climate change the focus is on meeting the twin needs of vulnerable countries for environment protection and economic development and assisting them in integrating adaptation into their multi-faceted planning and deliberative processes. Three key pillars were identified i.e.

- Building key adaptive capacity of developing world
- Increasing ecosystem resilience and reducing the risk of climate-related disasters

DEWA/GRID-Europe, 11, Chemin des Anémones, 1219 Châtelaine, Geneva, Switzerland
Tel. [4122]917. 81.69, Fax. [4122]917.80.29, Email: Woerden@grid.unep.ch

- Mobilizing and using knowledge for adaptation planning

Twelve actions have been proposed around these pillars, such as establishing a global adaptation network, undertaking a global adaptive capacity assessment, using knowledge for integrated adaptation planning, managing water resources, coastal zones and sensitive ecosystems, and reducing risk of climate-related disasters.

UNEP is to *improve the understanding of climate change science* and communicate key scientific messages regarding climate change in clear and understandable way, by means of:

- Supporting the IPCC by disseminating its assessments and special reports,
- Providing climate change information to national governments, in partnership with the IPCC,
- Improving the understanding of greenhouse gas emissions from deforestation and forest degradation, and
- Providing scientific, legal and institutional support to developing country climate change negotiators and their institutions.

The overall objective to *strengthen the ability of countries to integrate climate change responses into national development processes*, implying that UNEP will assist vulnerable states to adapt to a changing climate by building resilience in sectors of national priority with *special focus on national, sub-national and city-level assessments*, ecosystems management, economic incentives, disaster preparedness and supporting the achievement of the MDGs.

UNEP/DEWA, with the overall responsibility on [UNEP] science, has been asked 'to step up cooperation and engagement in the IPCC process' while this cooperation should 'be based on the common responsibility of bringing an understanding of the IPCC findings to bear on national development processes', and work on the need to provide credible assessments on impacts and adaptation to climate change at sub-regional and national scales. Basically, every credible integrated assessment of climate change depends to large extent on the availability of official statistics related to weather and climate as well as socio-economic trends.

3. How can this be translated to data needs [for addressing the climate change issues of adaptation and mitigation]?

Taking into account the above strategic framework, objectives and action plans to address climate change, and analyzing various IPCC reports, most notably those of WG2 and WG3 under AR4, as well as the Essential Climate Variables (ECVs) that support the work of UNFCCC and IPCC, one can distill a number of *scientific* data and indicators that are needed to analyze and *communicate* the issues of *adaptation to* and *mitigation of* climate change. Mitigation refers to anthropogenic interventions to reduce the sources or enhance the sinks of greenhouse gases, and adaptation is concerned with addressing the consequences of climate change. Their co-dependency (e.g. planting trees in urban areas both increases greenhouse gas sinks (mitigation) and acts to cool surrounding areas (adaptation) calls for or climate change policies that address the two responses simultaneously. Also, many experts see little utility in isolated climate data if they are not supported by those on socio/economic/natural resources and environment. An integrated approach is needed, along with a solid time coverage - long time series are required, going back 50 years or even more.

The most relevant identified sets of variables are the following:

A. Observed changes in climate and weather indicators (Intergovernmental Panel on Climate Change, 2007):
- Air temperature
- Ocean temperature
- Sea level
- Snow cover
- Mountain glaciers
- Arctic sea-ice extent
- Permafrost extent
- Heavy precipitation events
- Droughts
- Heat waves
- Tropical cyclones
- Cold days and nights
- Hot days and nights
- Hot extremes

B. Essential Climate Variables: (WMO/GCOS, http://www.wmo.ch/pages/prog/gcos/index.php?name=essentialvariables)
The Essential Climate Variables (ECVs) are required to support the work of the UNFCCC and the IPCC. All ECVs are technically and economically feasible for systematic observation. It is these variables for which international exchange is required for both current and historical observations. Additional variables required for research purposes are not included in this table. The order below is simply for convenience and is not an indicator of relative priority.

1) Atmospheric domain (over land, sea and ice):
   a) Surface: Air temperature, Precipitation, Air pressure, Surface radiation budget, Wind speed and direction, Water vapour.
   b) Upper-air: Earth radiation budget (including solar irradiance), Upper-air temperature (including MSU radiances), Wind speed and direction, Water vapour, Cloud properties.
   c) Composition: Carbon dioxide, Methane, Ozone, Other long-lived greenhouse gases, Aerosol properties.
2) Oceanic domain:
   a) Surface: Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Current, Ocean colour (for biological activity), Carbon dioxide partial pressure.
   b) Sub-surface: Temperature, Salinity, Current, Nutrients, Carbon, Ocean tracers, Phytoplankton.
3) Terrestrial domain: River discharge, Water use, Ground water, Lake levels, Snow cover, Glaciers and ice caps, Permafrost and seasonally-frozen ground, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI), Biomass, Fire disturbance, and as emerging ECV: Soil moisture.

C. Key impacts as a function of increasing global average temperature change (impacts will vary by extent of adaptation, rate of temperature change, and socio-economic pathway) (derived from IPCC Figure AR4-WG2 SPM.2):

Water:	Water availability and droughts in tropics, high latitudes, mid-latitudes and semi-arid low latitudes Number of people exposed to (increased) water stress
Ecosystems:	Number and risk of extinction Coastal wetlands, area Coral bleaching Species range shifts and wildfire risk
Food:	Productivity of cereals at low-mid-high altitudes Local impacts on small holders, subsistence farmers and fishers
Coasts:	Number of people exposed to coastal flooding each year Damage from floods and storms Average rate of sea level rise
Health:	Changed distribution of some disease vectors Burden from malnutrition, diarrhoeal, cardio-respiratory, and infectious diseases Morbidity and mortality from heat waves, floods, and droughts Burden on health services (expenditures)

D. <u>Mitigation variables:</u> (derived from IPCC Figure AR4-WG3 SPM.3)

General:	GHG emission trends (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) Population, urban and rural, poverty, migration Land cover and land use change, land degradation GDP and PPP, sector value added, household consumption
Energy:	Energy use, supply and intensity (by sector), production and use of renewable energy (solar, wind, hydro, geothermal, biofuels), nuclear power, natural gas, coal, oil, gas.
Transport:	Number of hybrid and cleaner diesel vehicles, transport volume by rail/road/water/air/non-motorized
Buildings:	Use of energy-saving bulbs, improved cook stoves, isolation
Industry:	Material recycling and substitution rates, heat and power recovery etc.
Agriculture:	Afforestation, reforestation, forest management, avoided deforestation, harvested wood product management
Waste management:	Landfill methane recovery, composting of organic wastes, waste disposal, treatment and recycling, waste water treatment
Policies:	Climate policies and measures, carbon prices, emission trading, budgets and expenditures for climate policies, meteorological monitoring.

4. And how does this again translate into needs for official statistics?

Many of the above world-wide climate-related data and indicators are collected through scientific measurements e.g. temperature, precipitation, radiation and so forth. Others are compiled by international agencies on the basis of statistical surveys, often using national statistical sources and more recently also remote sensing data. This holds for example for population (UN Population Division), GDP (UNSD and World Bank), forestry and agriculture (FAO), health (WHO), energy (IEA) etc. But various additional data need to be collected and/or compiled to adequately address the climate change adaptation and mitigation issues. If one then tries to identify those additional data and indicators for which it is expected that national statistical offices can play a role in (strengthening of) collecting information on a regular basis, one can distill the following list:

- Air emission reporting, most notably in non-Annex 1 countries, and including underlying energy and activity data
- Data on infrastructure development (roads etc) and building volumes (houses, offices, industrial plants etc)
- Use of energy-saving technology (bulbs, building isolation, hybrid cars etc)
- Use of certified wood products
- Use of emission trading and climate compensation schemes (including carbon prices)
- Volume data on transport modes (motorized and non-motorized)
- Material recycling and substitution
- Water use
- Land/vegetation cover and ecosystems areas (wetlands, coasts)
- Species extinction, migration patterns
- Harvest and crop production (wheat, maize, rice etc)
- Mortality and morbidity (specific diseases)
- Number and extent of natural disasters (floods, fires, storms, droughts, heat & cold waves) and the damage they cause
- Budgets and expenditures on health services, disaster prevention & damage repair

The challenge is to identify and specify those data variables for which new or additional efforts are needed by statistical offices and international partners in the immediate future. Such variables could include for example: carbon emission trading, number and extent of natural disasters by type, budgets/expenditures on climate-related preventive measures and disasters, material recycling and substitution, use of renewable energy sources, eco-labelling and use of certified products.

5. <u>Conclusion</u>

Climate change is now at the top of the world's agenda, and adaptation and mitigation are among the biggest challenges ever faced by society. UNEP is making its contribution by committing to communicate and address the issues of adaptation and mitigation based on sound data and science to policy-makers and the wider public. While a vast amount of data and indicators is already available for analysis and information purposes, more data of high quality are needed and national statistical offices can play an important role in collecting new and additional data and, together with UNSD and other agencies, also in strengthening and harmonizing existing surveys and other data collection activities in the area of adaptation to and mitigation of climate change.

Besides 'real' physical climate data, it is important to consolidate and improve authoritative data collections and compilations in the socio-economic and natural resources realms, using statistical surveys but possibly also other sources such as satellite imagery – the end goal is having proper, authoritative data in place to assess and address climate change issues adequately at all levels.

Session 2 : Conference papers

The Use of UN-Supplied Fuel Production and Trade Statistics for the Estimation of Global and National Fossil-Fuel-Derived Carbon Dioxide Emissions

RJ Andres[1], TA Boden[1], G Marland[1, 2]

[1]Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6335 USA

[2]International Institute for Applied Systems Analysis
A2361 Laxenburg
Austria

andresrj@ornl.gov, bodenta@ornl.gov, marlandgh@ornl.gov

ABSTRACT

Statistics on the production, transfer, transformation, and consumption of fuel are collected by various governmental, public, and private entities. These statistics are compiled by national statistical offices (NSOs). NSOs forward summaries of these statistics via questionnaires to international organizations such as the United Nations Statistics Division (UNSD) and the International Energy Agency (IEA). These international organizations make these statistics available to the general public, government entities, private firms, and non-governmental organizations through a variety of means. These individual groups then use these statistics for a multitude of applications.

This presentation will focus on one such application: the estimation of global and national carbon dioxide emissions from fossil-fuel consumption. In addition to the fossil-fuel statistics, these estimates also rely on a knowledge of fuel chemistry and combustion conditions. Personnel at the Carbon Dioxide Information Analysis Center (CDIAC) at Oak Ridge National Laboratory (ORNL), USA, have for three decades made annual estimates of fossil-fuel-derived carbon dioxide emissions. New releases of the emissions data are made each year when another year of fuel statistics becomes available from the UNSD. This presentation will briefly review how the emissions estimates are made on both a global and national basis. These estimates are only made after the completion of a quality assurance/quality control (QA/QC) procedure. The QA/QC procedure is an interactive process with the UNSD that helps ensure the UNSD fuel statistics release is internally consistent. The presentation closes with a brief description of a value-added product produced at CDIAC: the distribution of the national emissions at a one degree latitude by one degree longitude scale.

INTRODUCTION

Until very recently, official national statistics did not exist that specifically addressed the emission of gases of interest to the climate change issue. Even today, these climate change statistics are not comprehensive in terms of their global coverage at regular time intervals. However, this recent focus on greenhouse gas emissions and its limited implementation, evidenced by national inventories reported to the UN Framework Convention on Climate Change, has not precluded a long term, systematic, consistent, global exploration of these emissions. For example, the emissions of carbon dioxide from fossil-fuel consumption have now been estimated annually for more than three decades. The initiation of these estimates was stimulated by the measurements of increasing atmospheric carbon dioxide concentration performed at the Mauna Loa Observatory by C.D. Keeling (Keeling, 1960).

This early and continuing estimation of annual emission of carbon dioxide to the atmosphere from fossil-fuel consumption has proved to be important in understanding the global carbon cycle as this emission source has been shown to be the major contributor to the increasing levels of carbon dioxide in the atmosphere (IPCC, 2007). Carbon dioxide, in turn, has been shown to be the single largest contributor to the changing radiative forcing now affecting our climate (IPCC, 2007).

The remainder of this paper will examine the continuing estimation of the annual emission of carbon dioxide to the atmosphere from fossil-fuel consumption. The paper will briefly describe how the data for this estimation are compiled, the estimation process itself, and some of the data products that result from the estimation process.

FOSSIL-FUEL DATA SOURCES

The estimates of carbon dioxide emissions from fossil-fuel consumption are derived from three basic pieces of data: national estimates of fossil fuels consumed, the fraction of that fuel actually combusted, and the carbon content of that fuel. For more detailed information on the mechanics of this estimation process, please see Marland and Rotty (1984) and Andres et al. (1999). The remainder of this section will concentrate on the portions of this estimation process deemed most pertinent to this Conference on Climate Change and Official Statistics.

Figure 1 shows the basic process of energy statistics data flow in the estimation of greenhouse gas emissions. The left-hand portion of the diagram shows the data being increasingly aggregated and consolidated as they move from individual data sources to bodies of increasing geographic scope (e.g., national statistic offices (NSOs) and the United Nations Statistics Division (UNSD)). The energy statistic data collated through this process include data on production, transfer, transformation, and consumption of 35 solid, liquid and gaseous fossil fuels (other fuels and electricity are also surveyed by the UN, but are not discussed here). UNSD gets this information from the NSOs via an annual questionnaire. For all fuels and for all categories of data collection, not every country completes each cell in the questionnaire completely or accurately. This may be due to a variety of reasons, including but not limited to incomplete data collection from the local statistics generation/collection bodies, differences in interpretation of category definitions, and political/economic/environmental reasons. The annual questionnaire allows for revisions of data submitted in prior years. For the year 2004 release of the data, the UNSD data set contains more than 2.2 million individual pieces of fossil-fuel related data with just under 2% (43,578 data points) of this total added specific to the 2004 data year.

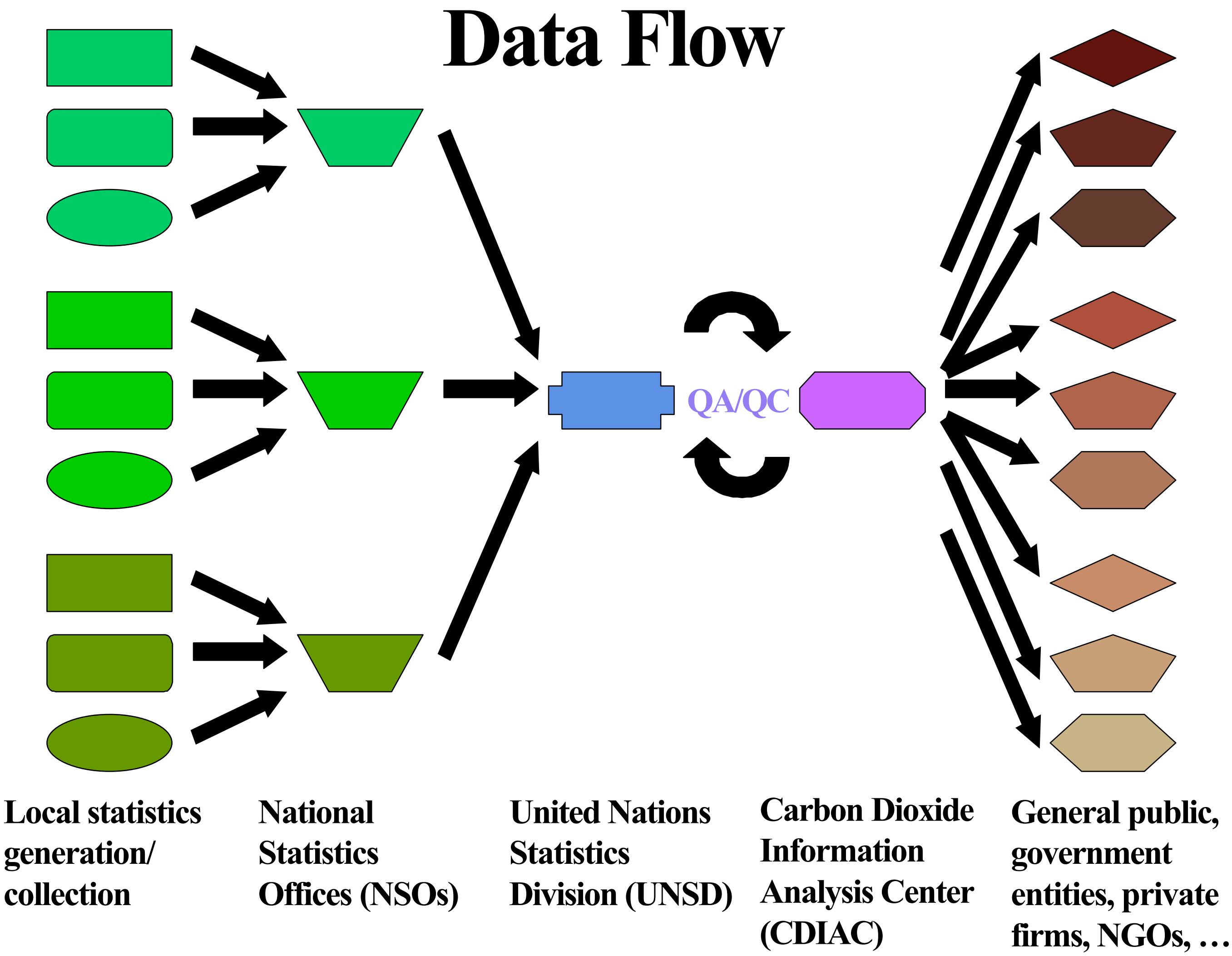


Figure 1. Data Flow Diagram Showing the Nearly Monotonic Flow of Data from Local Statistics Generation to Final Users of Carbon Dioxide Emissions Estimates. An exception to the monotonic data flow from data collection to carbon dioxide estimates is an interactive quality assurance/quality control (QA/QC) process between UNSD and CDIAC. Note that this data flow diagram is drawn from the perspective of personnel at CDIAC and therefore does not reflect QA/QC and other interactive processes at the left-hand side of the diagram.

After the questionnaires are received by UNSD, the data they contain are input into the UNSD data system. When all countries have reported data from a complete year, the data are shared with the Carbon Dioxide Information Analysis Center (CDIAC) at the Oak Ridge National Laboratory (ORNL), United States. CDIAC then performs some quality assurance/quality control (QA/QC) checks before using the data to estimate carbon dioxide emissions. This QA/QC process is an interactive process with the UNSD that helps ensure the completeness and consistency of the energy statistics data set. These QA/QC checks include items such as a review of the consistency of time series data, identification of improper or missing codes (e.g, country codes, transaction codes, fuel types, mass or volume units), and that sums of disaggregated quantities equal the aggregated quantity. Simple inconsistencies are addressed with the UNSD before release of the year's data to the general public. Other inconsistencies are made over the ensuing year(s) as their nature is more fully explored and clarified.

With release of the UN data to the general public, CDIAC then combines the UN fuel statistics with information on the fraction of that fuel actually combusted and the carbon content of that fuel to produce its estimates of carbon dioxide emissions from fossil-fuel consumption. These estimates are then compiled in a variety of formats and value-added products (discussed below) and ultimately released to the general public and other interested parties, primarily through internet-based means.

Before describing the data products of CDIAC, we briefly digress and describe the time to delivery of the final data product to the general public. As an example, we examine data from the latest available year. In December 2007, CDIAC received from UNSD the energy statistics for 2005. Thus, after the conclusion of the 2005 calendar year, it took almost two years for the data to be fully transported from the Local Statistics Generators to the NSOs to UNSD, to be compiled, supplemented where necessary, and checked. This time frame has been typical over the last few decades. The QA/QC process at CDIAC is now ongoing. CDIAC expects to release the 2005 carbon dioxide emissions estimates early in the late spring or early summer of 2008. Thus, the full process from close of the calendar year to release of carbon dioxide emissions data products to the general public takes approximately 2.5 years.

CDIAC DATA PRODUCTS

CDIAC-produced data releases are based on a relatively simple equation:

carbon dioxide emitted = fuel consumed * fraction of that fuel actually combusted * carbon content of that fuel.

The implementation of this equation becomes a bit more involved as one keeps track of the 35 fossil solid, liquid and gaseous fuels, their relative combustion efficiencies, and their relative carbon contents. However, good accounting and database principles make this a tractable problem.

In addition to estimating carbon dioxide emissions from fossil-fuel consumption, the CDIAC-generated data products also include carbon dioxide emissions from cement manufacture. The basis for this inclusion is relatively similar to that for fossil fuels: there are reliable statistical data which track cement manufacture, by nation, globally (USGS, 2007). Additionally, cement production is one of the larger emitters of carbon dioxide after fossil-fuel consumption (approximately 3% of the fossil-fuel-produced carbon dioxide total). It is important to note that the carbon dioxide emissions from cement manufacture arise from the conversion of calcium carbonate (often in the form of limestone) to cement clinker (the dry product used as the basis for making cement). Chemically, this can be represented as:

$CaCO_3$ -> $CaO + CO_2$.

The carbon dioxide produced by the fuel consumed to drive this transformation is tracked under the fossil-fuel-derived carbon dioxide emissions, not the cement-derived emissions.

Two primary data products are derived from the UNSD-supplied energy statistics: an estimate of global carbon dioxide emissions from fossil-fuel (and cement) production and an estimate of national carbon dioxide emissions from fossil-fuel (and cement) consumption. Global estimates are based on production statistics rather than on consumption statistics for several reasons:

1. There are relatively fewer entities involved in the production of fossil fuels as compared to their consumption. Thus, the universe of entities to be surveyed is smaller.
2. The production of fossil fuels is closely monitored by most nations as it is an important source of tax revenue.
3. Production statistics ignore some of the complexities involved in national consumption statistics such as imports, exports, changes in stocks, and bunker fuels (i.e., those fuels used in international trade and thus are not accountable to any one nation by commonly accepted protocols) as well as fuels consumed for non-fuel uses (e.g., petroleum being consumed to produce plastics).
4. The ratio of fuel stockpiling to fuel production is small so that essentially all fuel produced in a given year is also consumed in that given year.
5. The four reasons listed above lead to a more accurate and thus lower error estimate for a global total based upon production statistics than one based upon national consumption statistics. Global consumption statistics are not tracked, per se. This leads to an accuracy estimate of 6 to 10% for the global numbers at the 90% confidence interval (Marland and Rotty, 1984).

Estimates of global carbon dioxide emissions from fossil-fuel (and cement) production are released to the general public from the CDIAC website in both tabular and graphic formats (Figure 2).

Estimates of national carbon dioxide emissions from fossil-fuel (and cement) consumption are based on apparent consumption where

apparent consumption = production + imports - exports - changes in stocks - bunker fuels - production of non-fuel products

From this equation, it is clear that the sum of national emissions (calculated from apparent consumption statistics) will not equal the global total (calculated from production statistics) due to the exclusion of bunker fuels (Figure 3). The other terms of the apparent consumption equation also contribute to the difference. Despite the increased complexity in the calculation of the national totals, the average national total has an error estimate of 8.3% (similar to the global error estimate), but has a greatly expanded range of error estimates ranging from -340% (an underestimate) to 88% (an overestimate) (Andres et al., 1996).

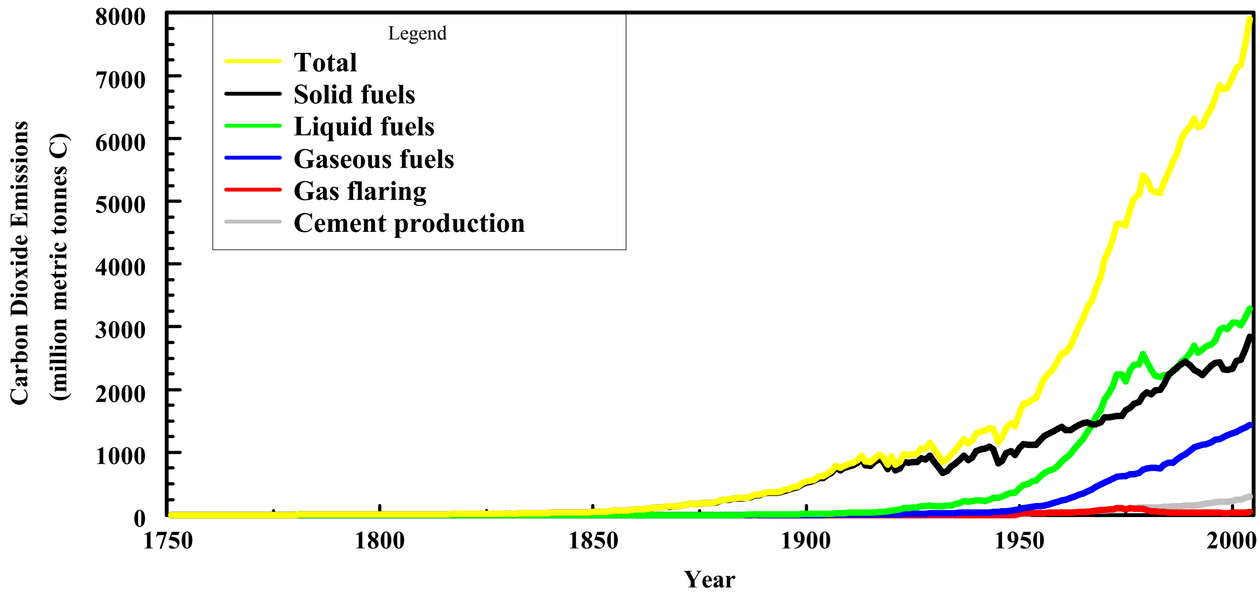


Figure 2. Global Carbon Dioxide Emissions from Fossil-Fuel (And Cement) Production. The pre-1950 data are from non-UNSD sources as described in Andres et al. (1999).

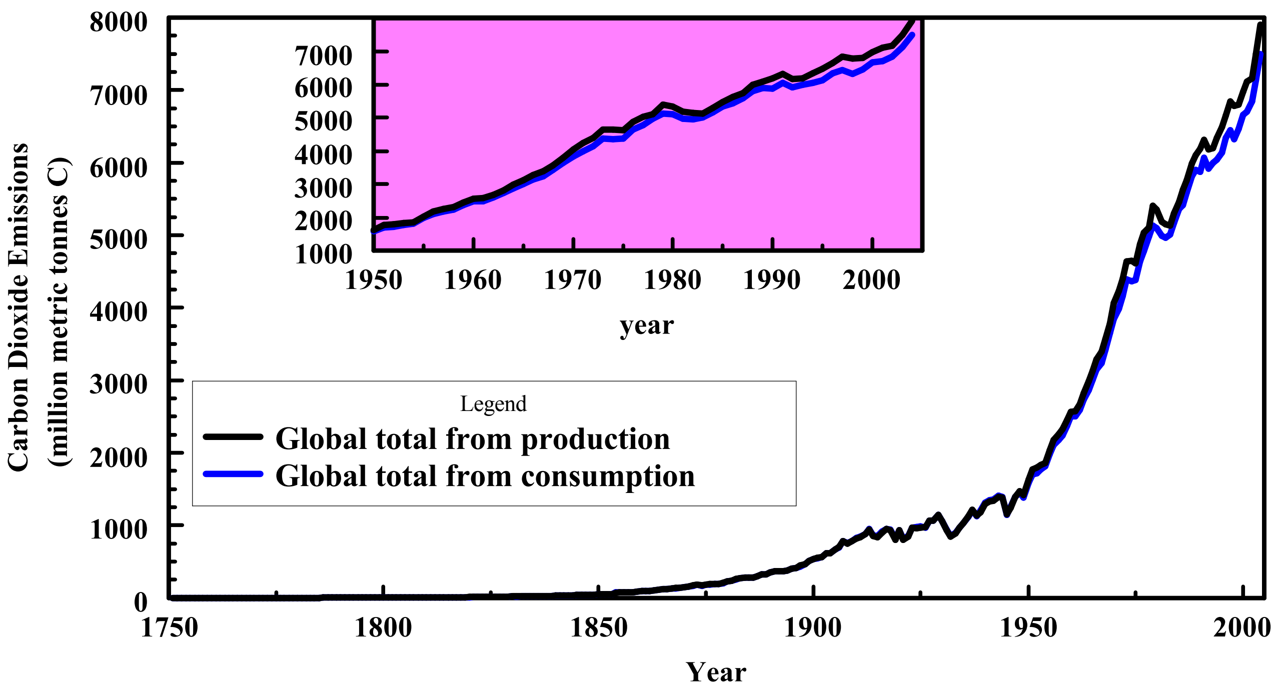


Figure 3. A Comparison of the Global Totals (as Calculated from Production Statistics) and Sum of the National Totals (as Calculated from Apparent Consumption Statistics). The inset is a zoom view of the 1950-2004 year interval.

After global and national fossil-fuel-derived carbon dioxide emissions are estimated, CDIAC then transforms these estimates into a variety of additional and value-added products. These products include regrouping of the national emissions in to regional totals, regrouping of the national emissions into Annex B and non-Annex B country totals as per the Kyoto protocol, combination of the national emissions with other statistical data to produce monthly emission estimates for some countries, combination of the national emissions with information on the stable carbon isotopic signature to produce the stable carbon isotopic signature of fossil-fuel carbon dioxide emissions (Andres et al., 2000), and the mapping of the national emissions onto a global 1 degree latitude by one degree longitude grid (Andres et al., 1996). All of these products supplement the carbon dioxide emissions data set (calculated from the UNSD-supplied energy statistics) with information supplied by other sources to meet end user needs. The remainder of this presentation will briefly describe the last of these products.

The mapping of national emissions onto a global grid (Figure 4) serves two major purposes. First, it allows easy visualization of the emissions; this is a distinct advantage over tabular listings of those same emission totals. Second, the gridding of emissions is of value to modelers who want to incorporate the spatial aspect of those emissions into their representations of the global carbon cycle.

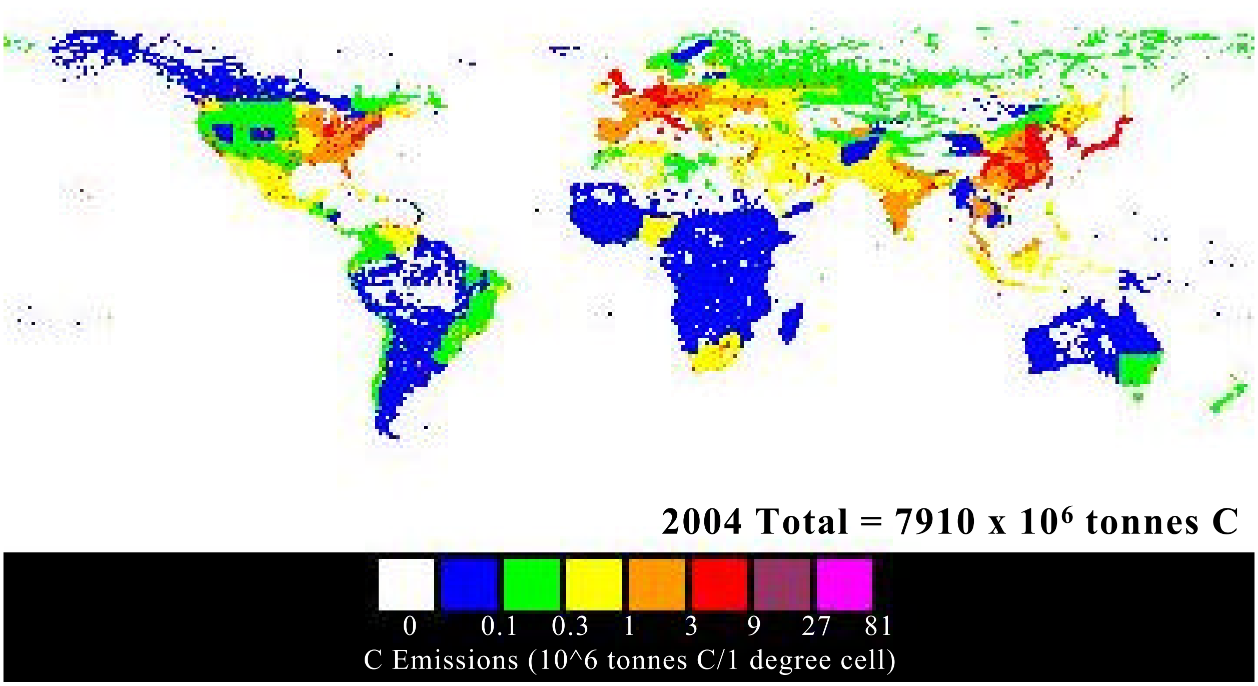


Figure 4. A One Degree Latitude by One Degree Longitude Plot of National Fossil-Fuel-Derived Carbon Dioxide Emissions (As Calculated from Apparent Consumption Statistics).

The gridding process is the result of the combination of three separate pieces of information. First, tabular data of the national emissions is obtained from CDIAC. Second, the tabular data are associated with a one degree latitude by one degree longitude map of countries; this gives the tabular data a geographic representation. Third, within each country, the emissions are distributed by a population distribution expressed on that same one degree scale; this further enhances the geographic representation as to a first order, higher emissions rates are associated with higher populations. Work is ongoing by persons at CDIAC and elsewhere to improve this emissions distribution by replacing the population proxy with a better distribution algorithm.

CONCLUDING REMARKS

Whether we are ready for it or not, national statistics are already being used to examine the climate change issue from a variety of angles. For example, over the year 2000- 2001 time interval, the data products CDIAC produces were downloaded from the World Wide Web an average of 74 times per day by unique users which include a variety of political, public, scientific, NGO, and other entities. The strategy CDIAC has adopted is to provide the best data possible and in the most useful formats as our resources allow. This has led us to examine the entire data flow process, our data processing algorithms, and our data distribution systems. For example, our interactive QA/QC process with UNSD is driven by our desire to have the best input data set possible. Likewise, we are continuously looking at our data algorithms to determine if a better processing algorithm exists based upon research that we or others have completed. Finally, our value-added products are a recognition that tabular data are not always the best way to convey the information that our data processing produces; new data products are developed as a community needs are identified and can be successfully addressed. CDIAC is supported by the United States Department of Energy and all data products are made available to users throughout the world at no cost. CDIAC staff are responsive to a wide variety of requests for further information, data products, and data formats from users. It is hoped that this presentation will not only encourage us all to produce the best data possible in our respective areas, but also encourage us to create productive collaborations where we can learn from the experience that each of us has gained in our respective areas.

REFERENCES

Andres RJ, Marland G, Boden T, Bischof S (2000) Carbon dioxide emissions from fossil fuel consumption and cement manufacture, 1751-1991, and an estimate of their isotopic composition and latitudinal distribution, in Wigley TML, Schimel DS (eds.) The Carbon Cycle. Cambridge: Cambridge University Press. 53-62.

Andres RJ, Marland G, Fung I, Matthews E (1996) A one degree by one degree distribution of carbon dioxide emissions from fossil fuel consumption and cement manufacture, 1950-1990. Global Biogeochem. Cycles 10:419-429.

Andres RJ, Fielding DJ, Marland G, Boden TA, Kumar N, Kearney AT (1999) Carbon dioxide emissions from fossil-fuel use, 1751-1950. Tellus 51:759-765.

IPCC (2007) Climate Change 2007: The Physical Science Basis. Contributions of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (eds.)). Cambridge: Cambridge University Press. 996 p.

Keeling CD (1960) The concentration and isotopic abundance of carbon dioxide in the atmosphere. Tellus 12:200-203.

Marland G, Rotty RM (1984) Carbon dioxide emissions from fossil fuels: A procedure for estimation and results 1950-1982. Tellus 36B: 232-261.

USGS (2007) U.S. Geological Survey 2005 Minerals Yearbook: Cement. 38 p.

Conference on Climate Change and Official Statistics
Oslo, Norway, 14 – 16 April 2008

Aija ZIGURE (Latvian Central Statistical Bureau – Juris FRIDMANIS (Latvian, Environment, Geology and Meteorology Agency)

National Reporting System on Greenhouse Gas Emissions: Latvian Experience

Development of environmental and climate policy in Latvia began with the country`s independence in 1991. A cornerstone for the national climate policy was put when United Nations Framework Convention on Climate Change in Rio de Janeiro UN Conference on Environment and Development in 1992 was signed. Progress towards the development of climate policy supported Latvia`s way towards joining the EU. Before Latvia had not developed special national climate change policy instruments and mitigation efforts were carried out through the combination of environmental protection policies and development strategies of individual economic sectors: energy, transport, agriculture, forestry, industry and waste management.

By ratifying the UN Framework Convention on Climate Change and the Kyoto Protocol, Latvia assumed the commitment of reducing the country`s greenhouse gas (GHG) emissions by 8% in 2008-2012, compared to the 1990 level. In 1990, Latvia emitted 25,894 thousand tons $CO_2$ equivalent, i.e., to meet its Kyoto commitments in the period of 2008-2012, Latvia`s annual emissions may not exceed 23,823 thousand tons CO_2 equivalent [Latvian Environment, Geology and Meteorology Agency, (LEGMA, 2006)]. The greenhouse gas emission forecasts made by the Ministry of Environment suggest that Latvia will meet its commitments under Kyoto Protocol.

Annual inventory of GHG emissions and CO_2 removals as well as National Inventory Report (NIR) is prepared by the Latvian Environment, Geology and Meteorology Agency. The Latvian Central Statistical Bureau (CSB) is the basic statistical and activity data provider to LEGMA. Ministry of Agriculture (MoA), Ministry of Transport (MoT) and enterprises are also co-partners by the elaboration of National Inventory Report. List of the main data and institutions responsible is given. After that when basic data are submitted to LEGMA the NIR is prepared by LEGMA. In separate cases Ministry of Agriculture prepares calculations of GHG emissions and CO_2 removals. The Ministry of Environment is supervising the process of preparation of GHG inventory and NIR.

Touching upon data collection in Latvia, since 2005, an institutional system involved in the gathering and processing of information related to environmental protection and sustainable development and responsible for environmental monitoring (including GHG emissions) and information dissemination to the public has also been developed. The institutions responsible for the Latvian GHG inventory are designated by the Ordinance of the Cabinet of Ministers No 220, also approving the Climate Change Mitigation Programme 2005-2010. A schematic model of the National system is shown in Figure 1

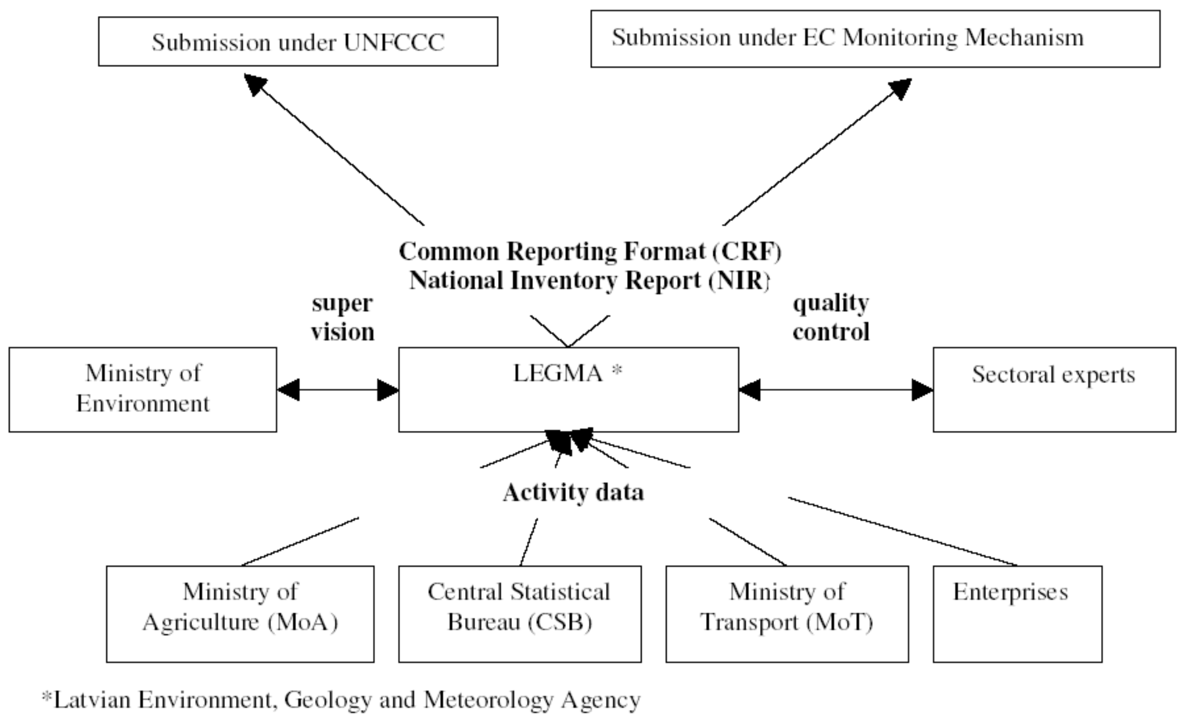


Figure 1. National reporting system on greenhouse gas emissions

The main data sources used for activity data and information and responsible institutions are presented in Table 1.

Sectors	Data Sources for Activity Data and Calculations	Responsible institutions
Energy	Activity data	CSB
	Calculations	LEGMA
Transport	Activity data	CSB, MoT
	Calculations	LEGMA
Industrial processes	Activity data	CSB, Plant operators
	Calculations	LEGMA
Solvent and other product use	Activity data	CSB
	Calculations	LEGMA
Agriculture	Activity data	CSB
	Calculations	LEGMA
Land Use, Land Use Change, Forestry (LULUCF)	Activity data	MoA
	Calculations	MoA, LEGMA
Waste, Wastewater Handling	Activity data	LEGMA
	Calculations	

Table 1. Main data sources for activity data and emission values

A comprehensive Quality control/Quality assurance Plan for Inventory compilation is under development.

ON THE PROBLEMS OF STATISTICAL DATA PROVISION FOR GREENHOUSE GAS EMISSIONS CALCULATIONS

1. The regulatory basis for the implementation of the national commitments on the Kyoto Protocol

Slide 2 enumerates the regulatory-legislative acts on the establishment and operation of the Russian System for the Estimation and Reporting on the Anthropogenic Emissions and Removals of the Greenhouse Gases under the Kyoto Protocol to the UNFCCC.

The national commitments of the Russian Federation on the Kyoto Protocol are implemented in accordance with the legal frameworks formed by the Federal Law of the Russian Federation "On the Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change" № 128-ФЗ of November 4, 2004 as well as the other regulatory documents developed and approved by the Government of the Russian Federation.

In accordance with the Federal Law № 128-ФЗ of November 4, 2004, the Russian Federation ratified the Kyoto Protocol to the United Nations Framework Convention on Climate Change (December 11, 1997), which was signed on behalf of the Russian Federation in New-York on March 11, 1999.

The Decree of the Government of the Russian Federation (№ 275-р, of February 20, 2006)

Identified the Ministry of the Natural Resources of the Russian Federation as the entity responsible for establishment and maintenance the national registry for accurate accounting, issuance, holding, transfer, acquisition, cancellation and retirement of emission reduction and other units in accordance with the provisions of the Kyoto Protocol to the UNFCCC

- Authorized the Ministry of Natural Resources in cooperation with the Ministry of Economic Development and Trade and in agreement with other concerned executive bodies of the government to elaborate and approve the procedure for establishment and maintenance of the National Registry of Emission Reduction Units.

The Decree of the Government of the Russian Federation (№ 278-р, of March 01, 2006)

- Identified the arrangements on the establishment of the National System for Estimation and Reporting on the Anthropogenic Emissions and Removals of the Greenhouse Gases under the Kyoto Protocol to the UNFCCC;

- Authorized Federal Service for Hydrometeorology and Environmental Monitoring (***Roshydromet***) as the entity responsible for the functioning of the National System and submission of the national greenhouse gas inventory and other relevant information to the UNFCCC and Kyoto Protocol Secretariat;

- Assigned the *Roshydromet* to develop the list of statistical information and activity data, which result in anthropogenic emissions from sources and removals by sinks of the greenhouse gases;

- Assigned the *Rosstat*, Ministry of Economic Development and Trade, Ministry of Natural Resources, Ministry of Regional Development, Federal Service for Technological Control and Ministry of Agriculture to ensure annual provision to *Roshydromet* of the activity data and other relevant information necessary for estimation of anthropogenic emissions from sources and removals by sinks of the greenhouse gases.

The regulatory frameworks for the implementation of the Kyoto Protocol also include the legislative acts by *Roshydromet* and other executive governmental bodies.

2. The functioning of the Russian System for the Estimation and Reporting on the Anthropogenic Emissions and Removals of the Greenhouse Gases under the Kyoto Protocol to the UNFCCC.

In accordance with the Decree of the Government of the Russian Federation, the *Roshydromet* ensures the functioning of the National System and submission of the National Greenhouse Gas Inventory and other relevant information to the UNFCCC and Kyoto Protocol Secretariat.

The *Roshydromet* elaborated and approved the Procedure of establishment and functioning of the National System for the Estimation of the Anthropogenic Greenhouse Gas Emissions and Removals together with the **list of state statistical reporting data** and other activity data, which result in anthropogenic emissions and removals of the greenhouse gases (the Order of the *Roshydromet* № 141 of June 30, 2006)

Slide 3 presents the functional scheme of the national system.

The *Roshydromet* in cooperation with the other participants of the national system develop the National Communication and the National Inventory of the Anthropogenic Greenhouse Gas Emissions from Sources and Removals by Sinks.

The estimation of anthropogenic greenhouse gas emissions from sources and removals by sinks is carried out by the *Roshydromet* on the basis of state statistical reporting and other data.

Every year the *Rosstat*, Federal Agency for Property Cadastre, Federal Forestry Agency, Ministry of Regional Development, Federal Agency for the Technological Control, Ministry of Transport and Ministry of Agriculture send to the *Roshydromet* the official statistical data and other information for the preparation of the greenhouse gas inventory.

***Rosstat* is the major provider of the official statistical data.**

Rosstat also undertakes quality assurance of the statistical data used by the *Roshydromet* for preparation of the national greenhouse gas inventory and national communication.

The Ministry of Economic Development and Trade, Ministry of Natural Resources, Ministry of Regional Development, Federal Service for Technological Control, Ministry of Agriculture and Ministry of Transport prepare and send to the *Roshydromet* reports on policies and measures in energy, agriculture, transport as well as specific data within their responsibility.

Every year by March 1, the Roshydromet submits for approval by the Government of the Russian Federation the National Greenhouse Gas Inventory of the Anthropogenic Emissions from Sources and Removals by Sinks, agreed with the concerned federal executive bodies. Every year the inventory includes the estimates for the years from 1990 to one but last year to the year of the submission.

After the approval by the Government of the Russian Federation, the *Roshydromet* submits the inventory to the UNFCCC Secretariat on behalf of the Russian Federation.

3. The role of the Federal State Statistics Service (*Rosstat*) in the functional operation of the national system for the estimation of anthropogenic greenhouse gas emissions from sources and removals by sinks

As noted above, the *Rosstat* is the major provider of official statistical data.

The statistical activities in the Russian Federation are organized in accordance with the Federal Law “On Official Statistical Accounting and State Statistics System in the Russian Federation”, № 282-ФЗ of November 29, 2007

Slide 4 shows the basic responsibilities of the *Rosstat*

Thus, the ***Rosstat***

- Forms and publishes official statistical information on social, demography and environmental situation in the country;

- Guides the activities of ministries and agencies on development of state statistic resources and data;

- Provides for quality of initial statistical data and undertakes quality control of basic statistical data used by the *Roshydromet* for greenhouse gas anthropogenic emissions estimation;

- Develops a Federal Plan of statistical works on inter-agency basis.

The *Rosstat* develops official methodology for statistical activities and operation compliant with the international statistical standards, primarily with provisions of the SNA-93 SNS. This allows for comparability of the statistical data.

The Slide 5 presents the scheme of information flows within the *Rosstat*.

The **"bottom-up" approach** is used for statistical data collection**:**

The enterprises report to the territorial *Rosstat* bodies in accordance with the forms of the federal statistical observation.

The territorial *Rosstat* bodies undertake collection, integrity and quality control of the information, process and archive it along with ensuring the storage and protection of confidential information. The *Rosstat* territorial bodies also perform the aggregation of the information to the level of the subject of the Russian Federation and send it to the *Rosstat* Main Processing Center.

The Main Processing Center of the *Rosstat* undertakes collection and processing of the information from the territorial bodies of the *Rosstat*, implements control, archiving, storage and protection of confidential information. The aggregated information is sent to *Rosstat* for publication in statistical reports and provision to:

- The President of the Russian Federation, Federal Assembly of the Russian Federation, the Government of the Russian Federation;

.- *Roshydromet*, Ministry of Industry and Energy, Ministry of Natural Resources, Ministry of Agriculture, Ministry for Economic Development and Trade, and other government bodies;

- International organizations;

- other users.

Slides 6 and 7 show statistical data, which are compiled and submitted to the *Roshydromet* by the *Rosstat* on the annual basis:

Fuel and energy data

- The Fuel and Energy Balance
- Production in fuel and energy sectors; basic products output

Other industrial data

(production)

- Ferrous metallurgy
- Non-ferrous metallurgy

- Chemical and petrochemical industry
- Manufacturing and metal processing
- Forest, wood processing and pulp and paper industry
- Construction industry

Transport

- Cargo turnover (by transport type)
- Pipeline transport data (oil, gas and oil products)

Agriculture

- Agriculture production
- Agricultural crop areas
- Fertilizer input and chemical land reclamation
- Agricultural livestock and poultry population by type and by holding category
- Consumption of food products

Forestry

- Forest restoration
- Development of protection shelter belts (erosion-, pasture- and field protection)
- Forest fire data

The provision information and data for calculation of greenhouse gas emission performed by the other executive power bodies in accordance with their competence as shown on **Slide 8.**

The Agencies	**List of indicators by kind of activities**
● Federal Real Estate Cadastre Agency	**Land use** ● Land distribution by categories
● Federal Forestry Agency	**Forestry** ● State forest fund data ● Main cuts data ● Management and selective cuts data

- Federal Servise for ecological, technological and nuclear control — **Waste**

  Industrial and municipal waste formation, utilization, sanitation and storage

Slide 9 official statistical publications of the *Rosstat*:

- Official statistical publications include **20-23 issues per year;**

- Periodic publications (information and analytical materials annually published as **20-25 various statistical journals, reports and bulletins**);

- Electronic copies of publications are available through Internet Rosstat web-site **www.gks.ru** all is free

Slide 10 shows the Rosstat Internet website.

4. Reporting to the UNFCCC Secretariat

Slide 11 presents official submissions of the Russian Federation to the UNFCCC Secretariat in accordance with requirements of the Kyoto Protocol:

- Four National Communications and The Report on Demonstrable Progress (The Fourth National Communication was submitted on October 12,2006)

- National Inventory Report 1990-2004. (January 8, 2007)

- National inventory tables including those of Common Reporting Format for 1990-2004 and 1990-2005 (2007)

- Initial Report on the Assigned Amount (February 20, 2007)

All official submissions are available from the UNFCCC Secretariat website and **the** Roshydromet **(http:// www.meteorf.ru) website.**

The independent reviews of the official submissions of the Russian Federation coordinated by the UNFCCC Secretariat indicated that Russian Federation has no problems with its commitments under the Kyoto Protocol.

5. The difficulties in provision of statistical data for greenhouse gas emission calculation

The domestic (in-country) problems to be solved.

Slide 12 presents the data, necessary for the preparation of the greenhouse gas inventory for the key categories, which are, however, currently not available in the national statistics in required level of breakdown:

For example these are:

- Number probe oil and gas wells,

- Total length of medium and low pressure gas distribution network,

- Fuel used for international aviation and marine bunkers,

- Distribution of solid and liquid municipal waste by type.

With the aim to ensure completeness and quality of the national greenhouse gas inventory in accordance with provisions of the UNIFCCC and the Kyoto Protocol, the Roshydromet in agreement with other government executive bodies concerned prepares consolidated proposals on:

The improvement of the list of statistical indicators and other activity data for the estimation of anthropogenic greenhouse gas emission and removals referred to in the Order of Roshydromet № 141 of June 30, 2006;

- Develops the proposals on the enhancement of the state system of statistical reporting and submits to the Rosstat draft formulas for statistical data collection for their subsequent consideration and improvement.

In developing the greenhouse gas emission inventory in accordance with the IPCC methodology, the Russian Federation encounters the following difficulties, common for all countries (**Slide 13**). **They are caused by**:

- ❑ The difference between the classification by kind of activities and production types in the IPCC methodology and those used by the UN Statistics Division and Eurostat for economic activity data collection. In particular, this refers to energy and extraction industries, agriculture and land use

- ❑ The structural differences between the IPCC and IEA methodologies for greenhouse gas emission calculations as well as the approaches for fuel and energy balance construction.

  The latter requires specific conversion factors for enhancement of calculation results.

- ❑ Absence of List of fluorine containing products, which should be used in data collection on production, export and import for calculation of emissions of HFCs, PFCs, and SF6.

The decision of the above mentioned problems will increase quality of national cadastres of emissions and their methodological comparability.

Session 3 : Conference papers

The analytical usefulness of a system of environmental accounts

Rutger Hoekstra, Sjoerd Schenau and Peter van de Ven

Abstract: Economic activities lead to pressures on environmental systems because of emissions of pollutants and extraction of natural resources. This paper will argue and illustrate that the environmental accounting framework (SEEA, 2003) is particularly useful to assess the interrelationships between economy and environment. The primary reason for this is that the environmental accounts are entirely consistent with the system of national accounts. The environmental data can therefore be coupled to the framework of supply and use tables and input-output tables, giving ample opportunities for in-depth environmental-economic analyses. In this paper, we will provide some concrete examples from practice using data for CO_2-emissions for the period 1990-2005 in the Netherlands: structural decomposition analysis, the 'environmental balance of trade', the attribution of CO_2 to final demand categories, etc. The paper will conclude with a plea for increased international co-ordination and standardisation in the field of environmental accounting.

1. Introduction

The economy is a complex system of which production, consumption, technology and investment are just a few of the many different interrelated dimensions. All these different aspects of the economy may have detrimental or beneficial effects on environmental pressures. The relationship is further complicated by the fact that transboundary aspects (such as international trade and technological transfers) are becoming more and more important for economic and environmental analysis. As a consequence, the link between the economy and the environment is not straightforward. In this paper, we will argue that this complex relationship is best tackled using a statistical system which produce economic and environmental statistics in an integrated statistical framework. The environmental portion of this framework is usually referred to as the "environmental accounts" (SEEA, 2003). To illustrate the analytical usefulness of these accounts, we will use data on CO_2-emissions for the period 1990-2005 in the Netherlands. A number of analyses such as structural decomposition analysis, the 'environmental balance of trade', and the attribution of CO_2 to final demand categories are provided. We will also shortly discuss further opportunities for modelling applications, and the need for further statistical co-ordination.

This paper is structured as follows. After a short, more general discussion of the relationship between the economy and the environment in section 2, section 3 addresses the basics of environmental accounting. In section 4, a number of applications are illustrated using data for CO_2-emissions for the Netherlands. Finally, in section 5, we will put forward some recommendations which, in our opinion, are needed to take the environment into account.

2. Economic growth and the environment: A primer

The relationship between economic growth and the resulting environmental pressures has been one of the most important questions in environmental economics for a long time (think for example of Malthus, 1798; Meadows et al., 1972, WCED, 1987). In this 'growth debate', the main question is whether economic growth can continue indefinitely given the constraints set by the natural environment. Whereas some argue that this is possible (Beckerman, 1999), others are more pessimistic (Daly, 1999). Growth optimists expect that the positive correlation between economic growth and environmental pressure will, and already is, reversing. Growth pessimists believe that, in the long run, this will turn out to be impossible.

A line of empirical research that has led to significant debate is the Environmental Kuznets Curve (EKC). These studies are based on cross-sectional or time series data, which show an inverted U-shape relationship between economic variables and environmental pressures. The implication is that the environment is a luxury good, which receives more attention beyond a certain threshold of income or wealth. Grossman and Krueger (1995), for example, find that for the pollutants they investigate the turning point is below $8000 per capita. However, the results do not hold for all pollutants and furthermore the EKC is a black-box approach which does not explain the mechanisms that achieve this outcome. Doubts have, therefore, been raised over the robustness and generality of the EKC. Moreover, it has been suggested that relinking occurred in the late 1980s (de Bruijn and Opschoor, 1997; de Bruijn and Heintz, 1999). For an overview, see Dinda (2004).

Figure 1 shows the relationship between GDP-growth and CO_2-emissions for the Netherlands for the period 1990-2005. Conceptually, the figures for CO_2-emission and GDP can be compared, as both are derived from the same consistent system of environmental accounts. Figure 1 shows that for the period 1990-2005 *relative decoupling* took place in the Netherlands, i.e. the growth rate of CO_2 is lower than the growth rate of GDP. Note however that relative decoupling still leads to a net *increase* in environmental pressure. Only *absolute decoupling*, whereby environmental emissions decrease can lead to reduced pressure. As the figure shows, in the years 1996-97 and 1998-99 and more recently 2004-05 absolute decoupling occurred.

If the trend towards absolute decoupling is sustained after 2004, is this a good thing? The answer, perhaps surprisingly, is not a straightforward “yes”. A lot of the complexity of this question is caused by globalisation, in particular because of the re-distribution of production and consumption patterns. If figure 1 would represent global GDP and CO_2-emissions, it would be a positive development when the CO_2-emissions drop. For the sake of completeness, however, we should note that even a decrease in emissions could still be too slow to prevent a dramatic climate change and ecosystem collapse in the case of critical limits already being exceeded. In this paper, we will not dwell on this point.

Figure 1 only represents developments on a national scale, so we need to be careful of its interpretation. From the Dutch perspective, figure 1 represents a positive development, but this does not automatically translate into absolute decoupling on a global scale. The contrary could be the case - absolute decoupling for the Netherlands could actually go hand in hand with global increases in emissions, for example when ‘dirty’ industries move abroad.

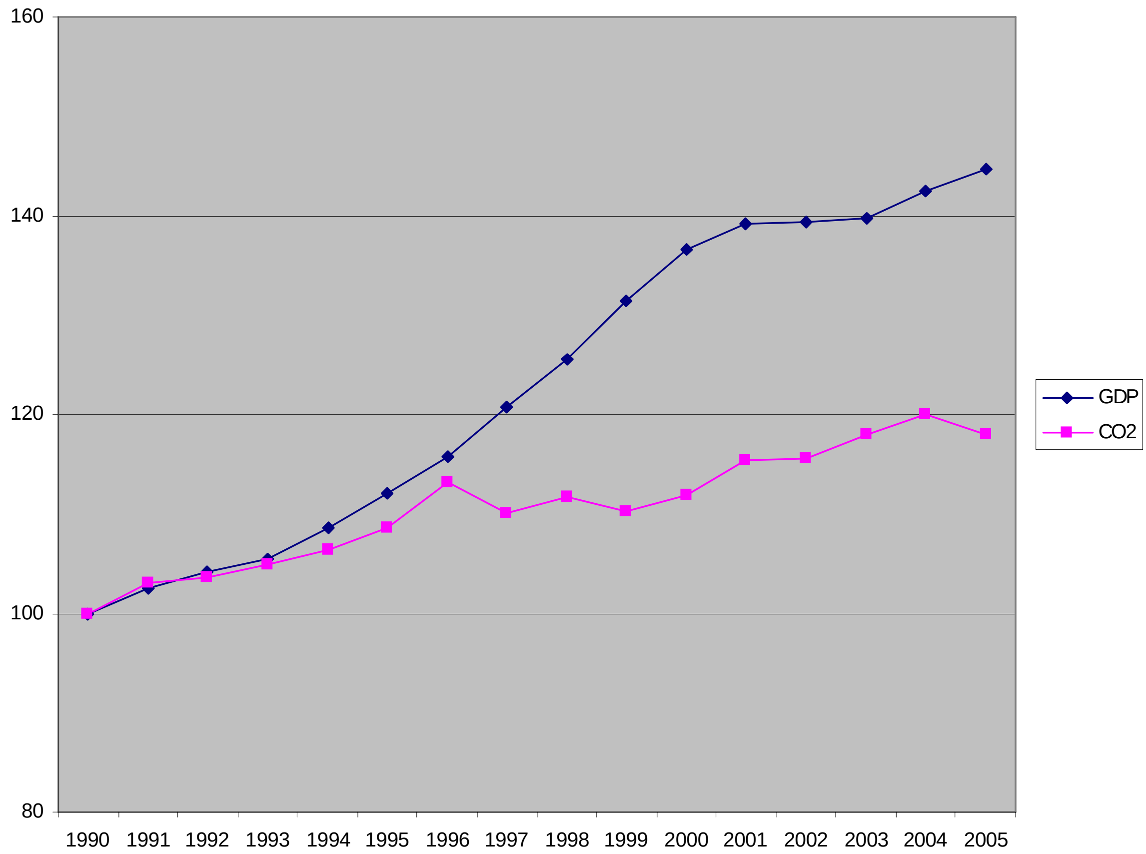


Figure 1. The development of CO_2-emissions and GDP in the Netherlands (1990=100)

Since economies are open systems, environmental pressures can be ‘exported’. Industries that produce CO_2 intensive products may go abroad because of environmental regulations or other reasons. These products are then simply imported. This mechanism will lead to decreases in the national CO_2-figures, because the CO_2 emitted in production processes abroad to produce our imports are not taken into account. This process is sometimes referred to as “carbon leakage” or the “pollution haven hypothesis” (PHH). Basically the hypothesis is that developed countries specialise in clean production and start to import the ‘dirty’ products from other (developing) countries. We will return to this point in our discussion of the ‘environmental balance of trade’.

3. Environmental Accounting

3.1 International Setting

Environmental accounts have been developed to link environmental and economic statistics. An important characteristic of environmental accounting is that the data are consistent with the national accounts. As such they are commonly referred to as 'satellite accounts'. The environmental data can be directly compared to macro-economic indicators such as GDP. Specific accounts cover natural resources such oil and gas, material flows, air emissions, water, waste, and environmental expenditure. The environmental accounts provide a tool to analyse to what extent our current production and consumption patterns are depleting natural resources or are polluting the environment. In addition, the system includes information about policy measures such as environmentally related taxes or subsidies.

International co-ordination of accounting practices culminated in the System of Integrated Environmental and Economic Accounting, commonly referred to as the SEEA 2003 (UN, 2003). The SEEA provides an overview of the different environmental accounts. Recently, the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) was established. Its main objective is the elevation of the system of environmental accounts to an international statistical standard and the implementation of SEEA in all countries. In Europe, Eurostat has also indicated that the development of the environmental accounts should be given high priority (Eurostat, 2003). On the national level, there is also much interest in the environmental accounts. Environmental policy institutes and ministries use this data for environmental-economic analyses and policy development.

3.2 Dutch Environmental Accounts

Statistics Netherlands has a long history in environmental accounting at the national accounts department (de Haan, 2004). In 1991, an illustrative NAMEA (National Accounting Matrix including Environmental Accounts) was presented for the first time (de Boo, Bosch, Gorter and Keuning, 1993), based on the conceptual design by Keuning (1993). The original design contained a complete system of national flow accounts, including a full set of income distribution and use accounts, accumulation accounts and changes in balance sheet accounts.

At present, a wide variety of different elements are produced on a regular basis by Statistics Netherlands. The air emissions accounts cover environmental information on climate change (emission of greenhouse gasses), ozone layer depletion, acidification, and local air pollution. In the energy accounts, the supply and use of energy products is shown both in physical and monetary terms. The waste accounts record the production and treatment of 70 different kinds of solid waste. The water accounts (NAMWA, National Accounting Matrix including Water Accounts) include both the production and consumption of water (tap water, groundwater, surface water), and the emission of hazardous substances to water (heavy metals, nutrients, pesticides etc.). The Dutch environmental accounts also include some monetary accounts related to environmental subjects, such as the environmental expenditure accounts and the environmental tax accounts.

The range of Dutch environmental accounts will be further expanded in the next few years. New work will be undertaken with regard to material flow accounts (MFA), asset accounts in monetary and physical terms for oil, natural gas, and land. The monetary accounts will be extended with the inclusion of environmental subsidies and the environmental goods and services sector.

4. The analytical usefulness of environmental accounts: some concrete examples

4.1 Introductory remarks

The environmental accounts have two primary features which make them very useful to investigate the relationship between the economy and the environment. First of all, environmental accounts are fully consistent with the system of national accounts. This means that the national accounting aggregates such as GDP, labour force, production, exports, imports, etc. can be linked to environmental indicators. Secondly, and related to the previous point, environmental accounts can be linked to the framework of input-output tables. The input-output tables are part of the national accounts system and can be used, among other things, for input-output modelling. This work was pioneered by Nobel laureate Wassily Leontief and provides a good basis for in-depth environmental-economic analyses. These two advantages will be illustrated below where we investigate a number of trends using data from the Dutch environmental accounts. The examples will mainly relate to the trade-offs between the economy and the CO_2-emissions in the Netherlands for the period 1990-2005.

4.2 Key indicators

One of the most important applications of the environmental accounts is the set of consistent indicators that can be derived from this integrated system. The environmental accounts provide key indicators which are consistent with economic figures. Table 1 illustrates the key figures published in the annual Dutch publication on environmental accounts (Statistics Netherlands, 2007a). The table provides an overview of both economic aggregates (GDP, final consumption of households, labour force, etc.) and environmental aggregates (emissions of greenhouse gasses, emissions of acidifying gasses, production of solid waste etc.). In addition, data is provided on environmentally related transactions (green taxes, environmental expenditure) and resource use of the economy (water use, energy use). Finally, the physical and monetary asset accounts for oil and gas are included in the table.

Table 1. Key indicators of the Dutch environmental accounts

	Unit	1990	1995	2000	2003	2004	2005	2006*
Domestic Product (gross, market prices)	mln euro	243652	305261	417960	476945	491184	508964	534324
Domestic Product (gross, market prices, price level 2000)	mln euro	306034	342776	417960	427765	437332	443937	457278
Value added (gross, basic prices)	mln euro	223832	275686	373415	425256	436874	451886	473610
Value added (gross, basic prices, price level 2000)	mln euro	276842	308196	373415	382985	391896	397663	409625
Final consumption expenditure households	mln euro	121102	151058	210823	238103	242781	249735	253482
Final consumption expenditure households (price level 2000)	mln euro	155860	170120	210823	216269	218390	220003	218182
Investments in fixed assets (gross)	mln euro	55328	63500	91652	92848	92426	96494	105283
Labour input of employed persons	1000 fte	5536	5774	6534	6547	6480	6463	6579
Population	1000	14947	15460	15922	16223	16276	16317	16341
Environmental costs 1)	mln euro	861	1209	1531	1615	1573	1548	.
Environmental investments1)	mln euro	556	418	417	295	382	338	.
Taxes	mln euro	62197	70835	99060	110177	113661	124039	132393
Green taxes	mln euro	5824	9249	13973	14975	16064	17270	18702
Environmental fees	mln euro	1619	2367	2906	3408	3583	3710	3956
Greenhouse effect	mln CO_2 -eq.	229448	245311	242117	245162	248654	244107	238801
Ozone layer depletion	1000 CFK11-eq.	4852	678	215	184	178	173	169
Acidification	mln ac-eq.	38	31	27	26	26	26	24
Fine dust	mln kg	86	67	59	53	52	52	47
Eutrophication 2)	mln eutr-eq.	223	213	173	162	143	146	.
Solid waste production	mln kg	52450	53983	64013	62748	62744	61213	.
Land filled waste	mln kg	14982	9209	4907	2756	1836	2137	.
Heavy metals to water 2)	1000 eq.	.	198	158	124	130	132	.
Nutrients to water2)	1000 eq.	.	29395	26699	25851	25783	25890	.
Net domestic energy consumption	petajoules	2899	3195	3357	3531	3602	3611	3527
Water use, groundwater extraction	mln m^3	.	.	.	1153	1044	1025	.
Mineral reserves gas	1000 mln Sm^3	2113	1952	1777	1615	1572	1510	1439
Valuation mineral reserves gas	1000 mln euro	70,4	74,4	72,5	100,8	103,0	100,0	109,0
Mineral reserves oil	mln Sm^3	64,0	50,0	30,0	38,0	34,0	35,9	38,1
Valuation mineral reserves oil	1000 mln euro	4,2	3,1	2,3	4,3	4,9	4,3	5,2

As stated, the above table is derived from the annual publication on environmental accounts, a publication that is entirely dedicated to environmental accounting issues. In addition, data on important environmental issues are also included in the annual publication on national accounts. The latter publication starts with a table containing core indicators for the Dutch economy. This set of indicators also includes several key indicators on environmental developments, right below economic growth and other more traditional key indicators for the economy. In the annex to this paper, the upper part of this table is shown.

Furthermore, the national accounts publication also contains a special section on environmental accounting. In this section, several summary tables are presented showing, for example, the link between production and consumption on the one hand, and environmental pollution on the other. Two of the relevant tables have also been annexed to this paper.

4.3 Transport efficiency

Although the key indicators are the summary statistics of the environmental accounting system, more detailed figures can also be produced. An example is the calculation of the transport efficiency of different transport activities. By combining data on transport performance (passenger kilometres, ton kilometre) with CO_2-emissions from the environmental accounts, the transport efficiency (CO_2 per passenger kilometre or ton kilometre) can be calculated. The environmental accounts are particularly suitable for this kind of analyses, because emissions abroad caused by residents are taken into account. Figure 2 shows the results for the different Dutch transport modes for passenger travel. Cars produce most CO_2-emissions per passenger kilometre while trains are most CO_2 efficient. A similar analysis has been made for the transportation of goods. Here, it shows that transport by train is most CO_2-efficient, followed by transport over water. Transport over land by trucks produces most CO_2 per ton kilometre.

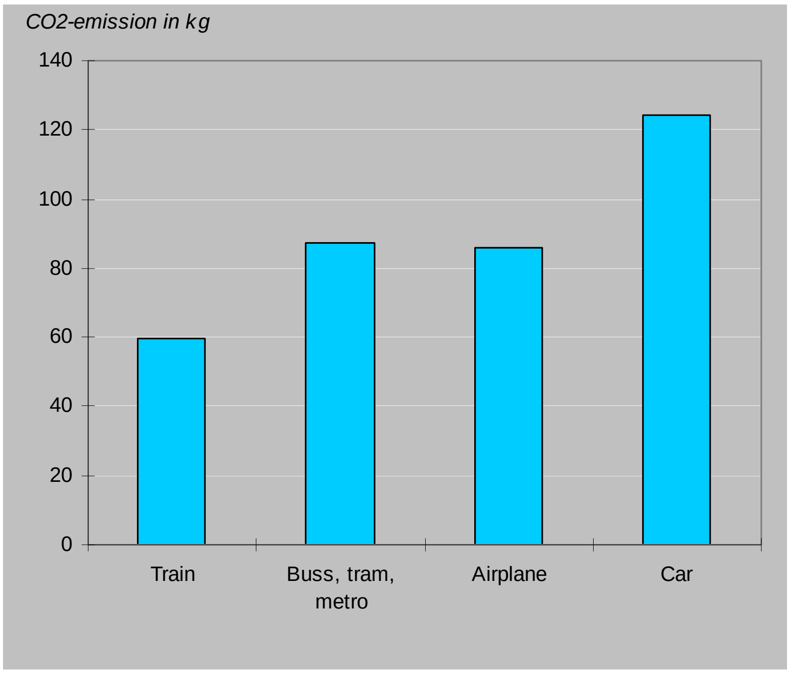


Figure 2. CO_2-emissions per passenger kilometre, 2003

4.4 The environmental balance of trade

The environmental accounts provide an excellent opportunity to test the Pollution Haven Hypothesis (PHH) which was discussed in section 2. By calculating the 'environmental balance of trade' for a country, insight is gained about the extent to which countries have shifted the environmental burden abroad (see amongst others Wyckoff and Roop, 1994; Antweiler, 1998; de Haan, 2001 and 2004; Machado et al., 2001; and Suh et al., 2002; Ahmad and Wyckoff, 2003; Peters and Hertwich, 2006; Peters, 2008). In this method, the embodied emissions (the direct and indirect emissions from the production process) of imports and exports are calculated using an input-output model. The model attributes emissions to exports and imports irrespective of the location where the emissions take place. The environmental balance of trade is equal to the embodied emissions in exports minus those in imports. If the PHH holds, one would expect the environmental balance to decrease in developed countries and to increase in developing countries.

Figure 3 suggests that the PHH does not hold for CO_2-emissions in the Netherlands. In the period 1990-2005, the environmental balance of trade is increasing slightly. The first results indicate that, on aggregate, the Netherlands is not shifting its environmental burden abroad in the case of CO_2-emissions. In fact, the opposite is true – our surplus for CO_2-emissions is increasing.

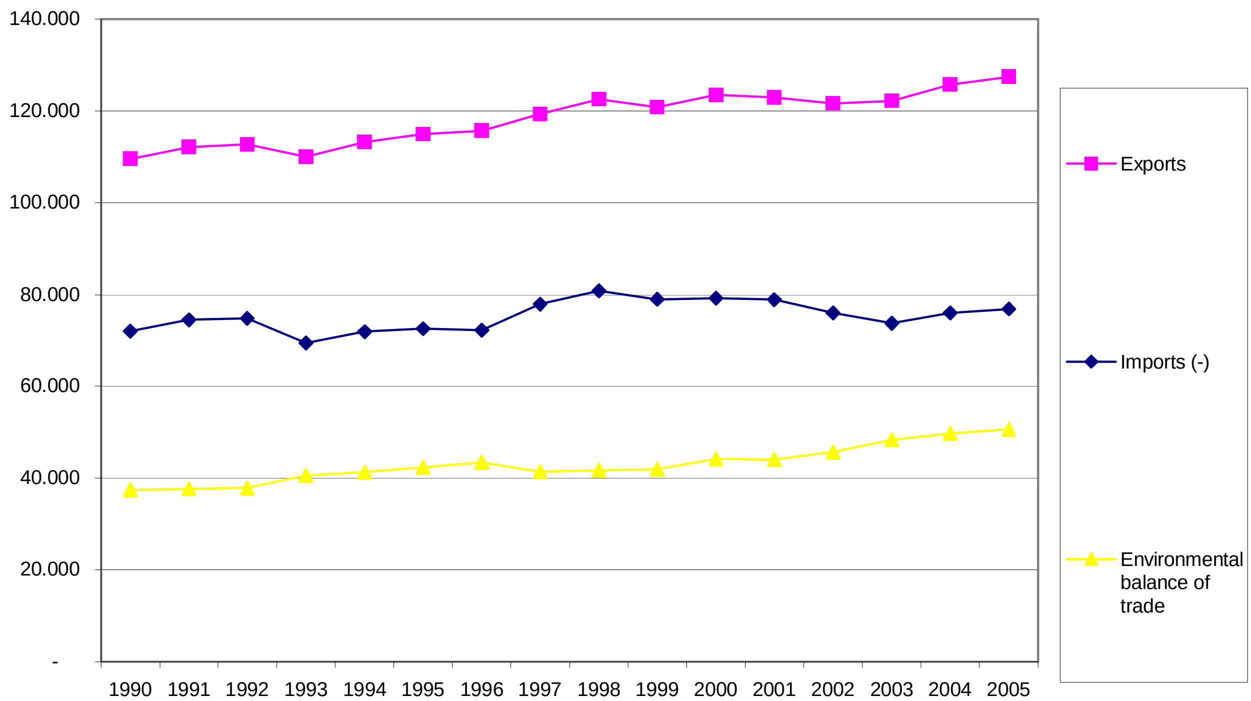


Figure 3. The embodied CO_2-emissions of imports and exports and the environmental balance of trade (million Kg)

These results for the Netherlands are not atypical. Empirical studies into the PHH show a mixed bag of results. Articles which support the PHH, such as Machado et al. (2001) and Wyckoff and Roop (1994), are contrary to others such as Jacobsen (2000) and Munksgaard and Pedersen (2001) which show results which counter the hypothesis. The results reflect the fact that the mechanisms at work are far more subtle than the simple statement "developed countries become clean at the expense of developing countries".

The environmental balance of trade may become a very important indicator for the analysis of the interrelationships between globalisation and environmental issues. It also addresses distributional issues in relation to environmental pollution among countries. Further enhancements of the methodology, however, are possible and necessary. Note, for example, that we could only conclusively falsify the PHH, if the origin and destination of imports and exports were also included in the calculation (see also de Haan, 2004). Furthermore, the standard assumptions of the input-output model apply and in addition it is assumed that the imported goods are produced using the same production (and emissions) structure as the Dutch economy. This latter assumption may have a significant impact on the embodied emissions of imports in particular.

4.5 Structural decomposition analysis

A widely used analysis is the so-called structural decomposition analysis (SDA); see Rose and Casler (1996), Rose (1999), Hoekstra and van den Bergh (2002), de Haan (2004) and Hoekstra (2005) for overviews of the literature, and de Haan (2001, 2004), Wilting *et al.* (2006) and Statistics Netherlands (2007a) for applications in the case of the Netherlands. The method uses the input-output model to decompose changes in the target variable (in this case, CO_2-emissions). In figure 4, the development of the CO_2-emissions have been decomposed into an efficiency effect (the effect of the improvement of the emissions per unit output), a structural effect (the effect of shifts in the structure of the economy) and the final demand effect (the effect of economic growth). As the figure shows, the effects of economic growth are the largest driving forces of emissions which are only partially negated by an increase in the efficiency. The figure basically shows that emissions would have been about 35% higher, if there had been no changes in efficiency and structure. Note that far more detailed SDA-specifications can be produced in which final demand and technological effects are decomposed into sub-components.

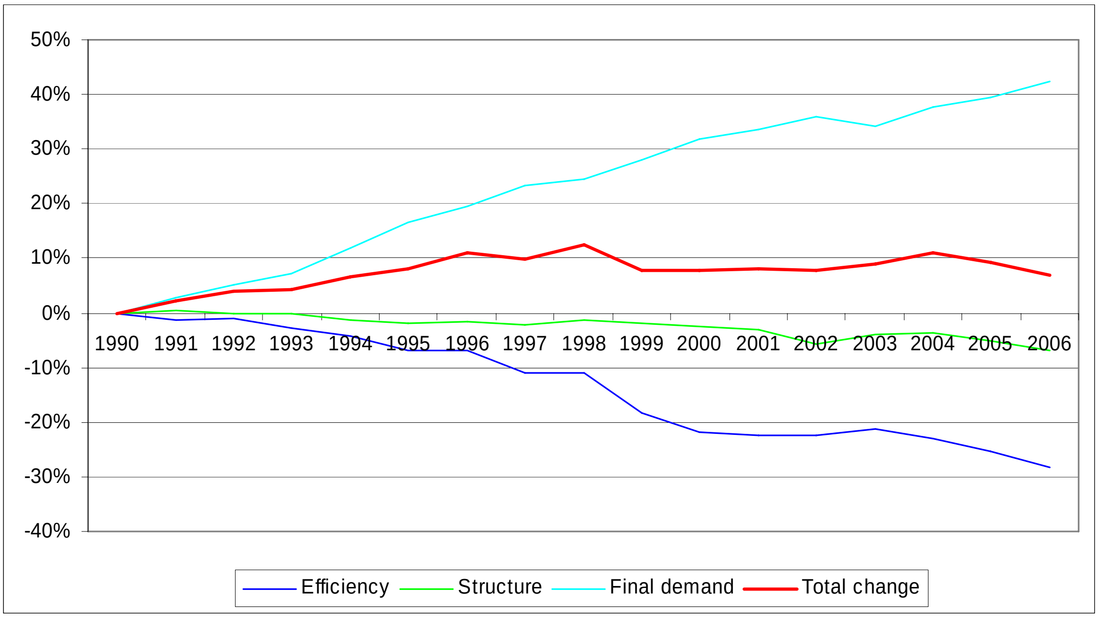


Figure 4. Structural decomposition analysis for greenhouse gasses (CO_2, CH_4, N_2O).

4.6 Attribution of CO_2-emissions to final demand categories

Using input-output kind of analyses, the CO_2-emissions caused by the production of goods and services can be attributed to the different final demand categories, such as exports, final consumption of households, final consumption of government and investments. The calculations are fairly similar to the calculations for the environmental balance of trade. More than half of the total CO_2-emissions caused by the Dutch economy is related to exports. One third of the emissions can be attributed to final consumption of households, and respectively 8 and 6 percent to final consumption of government and investments. CO_2-emissions caused by Dutch agriculture and transport are mainly related to export activities. Financial services emit CO_2 mainly for the benefit of household consumption.

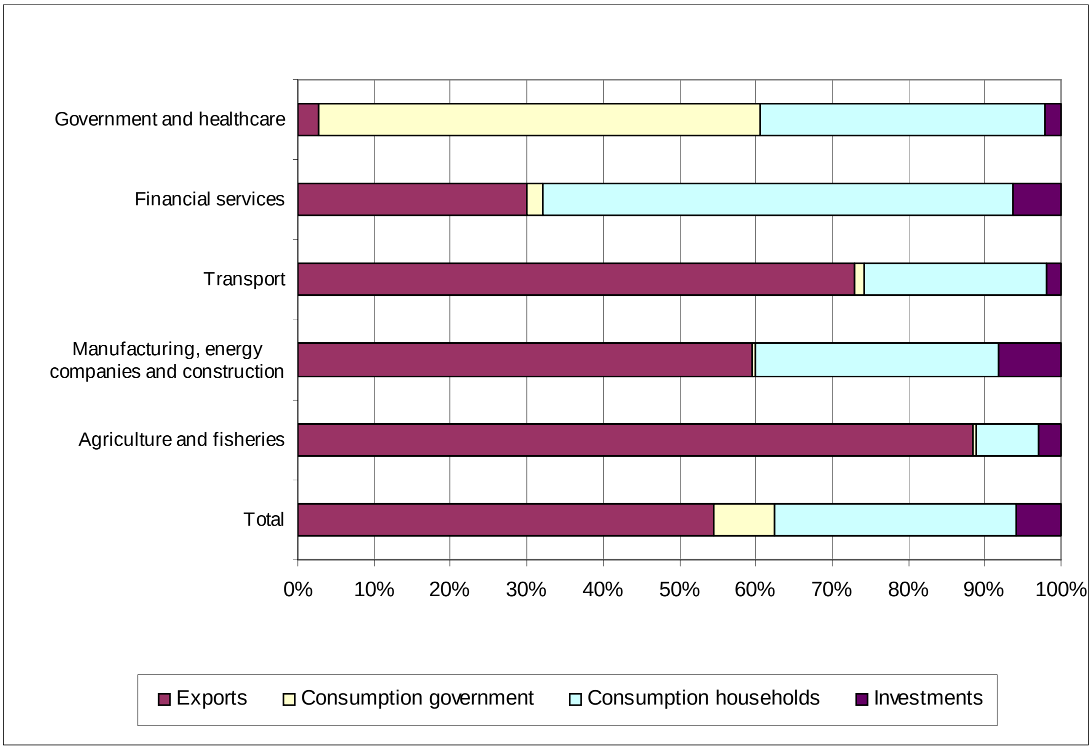


Figure 5. CO_2 emissions attributed to final demand categories, 2005

4.7 Other modelling applications

Most of the above applications are variations of the input-output model which are used to analyse historical developments. However, the environmental accounts can also be used to feed more complex macro-economic models, such as Computable General Equilibrium (CGE) models or dynamic input-output models. Figures 6 and 7 show scenario analyses which were produced by the Netherlands Environmental Assessment Agency using data from the environmental accounts[1]. In figure 6, the emissions of greenhouse gasses (GHG) by residents are projected to 2040. Four different scenarios have been distinguished: Global Economy (in which international co-operation on trade liberalisation increases, but less so on political and environmental issues), Strong Europe (in which further European integration is achieved), Transatlantic markets (in which European integration falters, but economic co-operation between Europe and the United States is enhanced) and Regional Communities (in which countries value their own sovereignty which causes economic and political integration to falter). Figure 7 shows the development of CO_2 emissions for one of the scenarios.

[1] We were kindly granted permission to reproduce these results from the publication 'Welvaart and leefomgeving' (CPB/MNP/RPB, 2006).

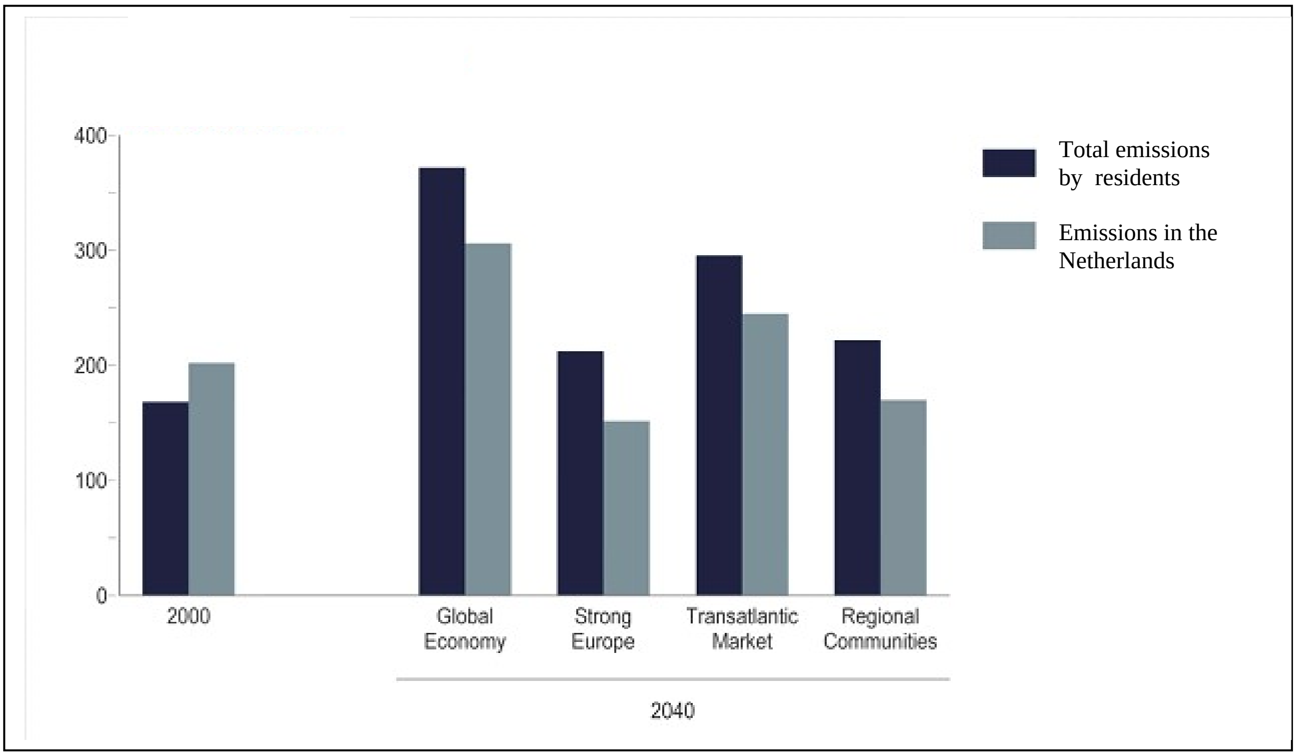


Figure 6. GHG-emissions of residents and emissions in the Netherlands for four scenarios

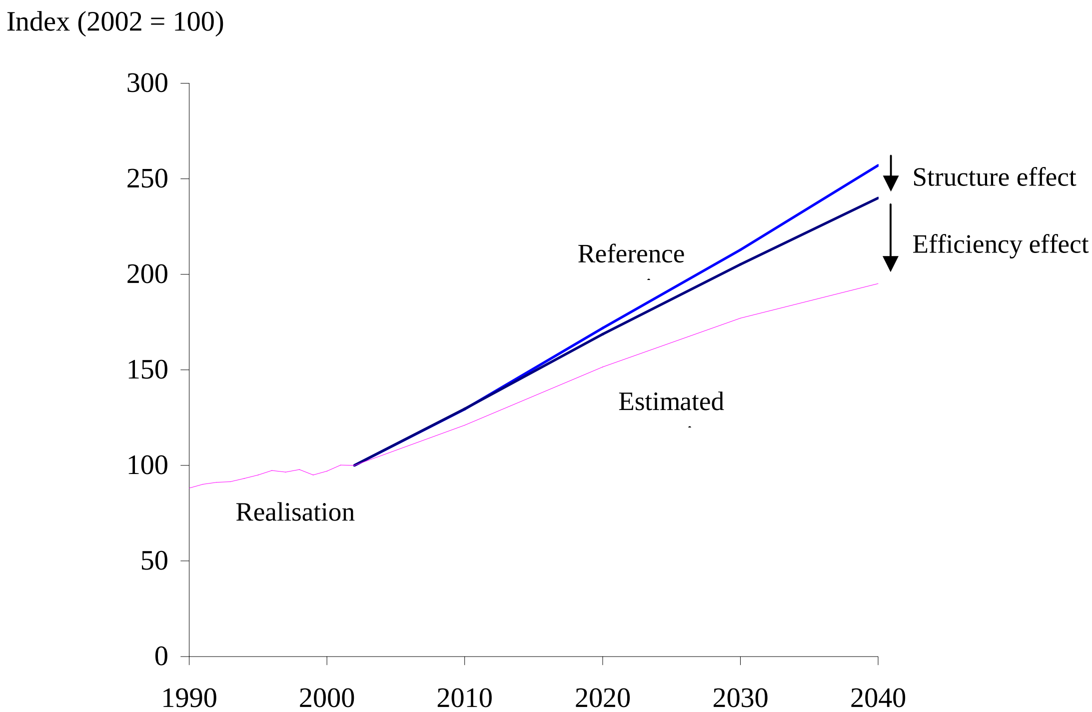


Figure 7. CO_2-emissions for the Global Economy scenario

Furthermore, in the Netherlands, the environmental accounts are also used for the calculation of the Sustainable National Income (SNI) (Gerlagh et al, 2002) at the Institute for Environmental Studies.

A further benefit of the environmental accounts is that they can also be coupled to other satellite accounts such as Tourism Satellite Accounts (TSA). By combining these two accounts one can calculate the environmental (direct and indirect) impacts of different types of tourists (daytrips, overnights stays, foreign visitors etc). Similarly, the environmental accounts could be integrated into growth accounts (which have just been published by the CBS for the first time). Natural resources already have been added to the growth accounting model, and perhaps emissions could at some stage be analysed as well.

A final point is that the possibilities for analysis have been enhanced by the fact that Eurostat now publish several environmental accounts, including air emissions, for many countries of the EU. By coupling these to the supply and use framework, the analyses mentioned in this section can be repeated for all countries. The data can also be used to further refine the analysis of the environmental balance of trade.

5. S.O.S – A Standard for Official Statistics

In section 4, we have shown that environmental accounts can provide very valuable and powerful tools to analyse the relationship between the economy and the environment. Note that none of the applications have valued the losses from environmental degradation. Our examples show that these valuations techniques are not necessary to provide policy makers, politicians and the general public with the information needed to make explicit choices between economic growth and environmental issues.

However, despite the abundance of information, economic growth is often put on a par with the development of societal progress at large. As a result, economic growth is nearly always given priority above other political objectives. In cases that growth of income can be combined with environmental issues, e.g. technological development to arrive at a decoupling of economy and environmental degradation, everyone is pleased. However, when a choice has to be made between less economic growth or less environmental pollution, income is the preferred option in most cases.

Environmentalists sometimes blame statistics for the above political choices, because issues such as environmental degradation are not properly reflected in GDP and economic growth. We think that this is a bit harsh and unjustified view on statisticians. It is for example important to realise that the System of National Accounts (SNA) 1993 explicitly states that GDP is a measure of economic activity and rejects the use of GDP as a measure of social welfare. In our opinion, however, macro-economic statisticians cannot completely ignore these allegations. Where economic statistics based on observable monetary transactions have developed to a very high standard, where international guidelines for the compilation of national accounts have been laid out in great detail, where the present-day system of national accounts is well respected by all people involved in macro-economics, the more ambitious goals of the origins of (welfare) economics seem to have been lost down the road. Where great emphasis is put on the compilation and publication of economic indicators, non-monetary issues affecting people's welfare are not given the same priority and attention.

The above reasoning does make statistics responsible, at least partially. It underscores the necessity to increase the statistical portfolio with accounts which address sustainability and welfare issues. By doing so, we will be able to provide a more balanced overview of societal developments and illustrate the deficiencies of economic growth as an overall indicator for societal progress. We should try to provide information about other important indicators for the development of a broader concept of welfare, in addition to and on an equal footing with GDP.

In the Netherlands, for example, plans are now in its final stages to develop and publish a 'Sustainability Monitor'. This monitor, initiated by government, will be a co-operative project between Statistics Netherlands (project leader), the Netherlands Bureau for Economic Policy Analysis, the Netherlands Environmental Assessment Agency, the Social and Cultural Planning Office of the Netherlands, and the Netherlands Bureaus for Spatial Research. The goal of the monitor is to provide a much broader picture of societal developments, with sustainability as the common denominator.

On the international level, a very promising development in relation to environmental issues is the creation of the United Nations Committee of Experts on Environmental Accounting (UNCEEA). It has been established with the approval of its terms of reference by the Bureau of the United Nations Statistical Commission in November 2005 (United Nations, 2005). In our opinion, two of the goals of the UN Committee should be given absolute priority. Both goals are more or less copied from the experiences, from the international "success story" of national accounts.

The first (short term) goal should be the definition of an internationally accepted core set of accounts and embedded indicators on the most urgent environmental issues. These tables should preferably be defined in such a way that the relevant data can directly be related to the core set of economic data, by using the same classifications and the same conceptual starting points. Doing so, the analytical usefulness, and as a consequence also the "attractiveness" of the relevant data will be enhanced significantly. Subsequently, it is important that the key tables are completed by as many countries as possible. For sure, one of the main advantages of national accounts is the international comparability of its main indicators, including the underlying frameworks. To achieve this goal in a reasonably short period, it is imperative to be as concrete and as focussed as possible.

The second important goal is the elevation of SEEA, the international guidelines for environmental-economic accounting, to an international statistical standard. Of course, it would be unrealistic to assume that this new standard will directly gain the same (long standing) status and reputation as the international guidelines for the national accounts, the SNA 1993 and its European equivalent, the European System of National and Regional Accounts (ESA) 1995. On the other hand, it is imperative to finalise the project of elevating the SEEA to an international standard as soon as possible. This will further enhance the implementation of standardised tables. It will also provide a clear benchmark for environmental accounting.

Therefore, our strong plea: S.O.S., a Standard for Official Statistics!

References

1. Ahmad, N. and A. Wyckoff, 2003. Carbon dioxide emissions embodied in international trade in goods. *OECD science, technology and industry working papes.* 2003/15, OECD publishing.

2. Antweiler, W., 1998. The Pollution Terms of Trade. *Economic Systems Research*. Vol. 8, No. 4 .

3. Antweiler, W., B.R. Copeland, M.S. Taylor, 2001. Is Free Trade Good for the Environment? *American Economic Review*, 91, pp. 877-908.

4. Beckerman, W., 1999. A pro-growth perspective, in J.C.J.M. van den Bergh (ed.), *Handbook of Environmental and Resource Economics*, Edward Elgar, Cheltenham, pp. 867–94.

5. Boo, A.J. de, Bosch, P.R., Gorter, C.N., and Keuning, S.J., 1993. An Environmental module and the complete system of national accounts, in: A. Franz and C. Stahmer (eds.), *Approaches to environmental accounting*, Physica-Verlag, Heidelberg.

6. Bruijn, S.M. de and J.B. Opschoor, 1997. Developments in the throughput-income relationship: theoretical and empirical observations', *Ecological Economics*, 20, 255–68.

7. Bruijn, S.M. de and R.J. Heintz, 1999. The environmental Kuznets curve hypothesis, in J.C.J.M. van den Bergh (ed.), *Handbook of Environmental and Resource Economics*, Edward Elgar, Cheltenham, pp. 656–77.

8. CPB/MNP/RPB, 2006. *Welvaart en Leefomgeving: een scenariostudie voor Nederland in 2040.*

9. Daly, H.E., 1999, Steady-state Economics: avoiding uneconomic growth, in J.C.J.M. van den Bergh (ed.), *Handbook of Environmental and Resource Economics*, Edward Elgar, Cheltenham, pp. 635–42.

10. Dinda, S., 2004. Environmental Kuznets Curve Hypothesis: A Survey, *Ecological Economics*, 49, pp. 431-455.

11. Eurostat (2003), *Environmental Accounts 2003 – Present state and future development*, Doc. ENV/072/8, Joint Meeting of the Working Groups "Environmental Statistics" and "Environmental Accounts" Joint Eurostat/EFTA group, 10-12 September 2003, Eurostat (Luxemburg).

12. Gerlagh R., Dellink, R.B., Hofkes, M.W. and Verbruggen, H., 2002. 'A Measure of Sustainable National Income for the Netherlands'. *Ecological Economics*, 41, pp. 157-174

13. Grossman, G.M. and A.B. Krueger, 1995. Economic growth and the environment, *Quarterly Journal of Economics*, 110, 353–77.

14. Haan, M. de, 2001. 'A structural decomposition analysis of pollution in the Netherlands', *Economic System Research*, 13 (2), 181–96.

15. Haan, M. de, 2004. *Accounting for goods and for bads. Measuring environmental pressure in a national accounts framework*, PhD thesis, Statistics Netherlands (CBS), Voorburg, The Netherlands.

16. Hoekstra, R. and J.C.J.M van den Bergh, 2002. Structural decomposition analysis of physical flows in the economy. *Environmental and resource economics*, 23, 357-78.

17. Hoekstra, R., 2005. *Economic Growth, Material Flows and the Environment: New Applications of Structural Decomposition Analysis and Physical Input-Output Tables*. Edward Elgar Scientific Publishers.

18. Jacobsen, H.K., 2000. Energy demand, structural change and trade: a decomposition analysis of the Danish manufacturing industry, *Economic Systems Research*, 12 (3), 319–43.

19. Keuning, S.J., 1993. An information system for environmental indicators in relation to the national accounts in: W.F.M. de Vries, G.P. den Bakker, M.B.G. Gircour, S.J. Keuning and A. Lenson (eds.), *The value added of national accounting*, Statistics Netherlands, Voorburg/Heerlen.

20. Machado, G., R. Schaeffer and E. Worrell, 2001. Energy and carbon embodied in the international trade of Brazil: an input–output analysis. *Ecological Economics*, 39 (3), 409–24.

21. Malthus, T. 1798. *An Essay on the Principle of Population*, 1st edition.

22. Meadows, D.H., D.L. Meadows, J. Randers and W.W. Behrens II, 1972. *The Limits to Growth*, Universe Books, New York.

23. Munksgaard J.1 and K.A.Pedersen, 2001. CO_2 accounts for open economies: producer or consumer responsibility? *Energy Policy*, Volume 29, Number 4, March 2001 , pp. 327-334(8)

24. Peters, G.P. and E.G. Hertwich, 2006. Structural analysis of international trade: environmental impacts of Norway. *Economic Systems Research*, Vol. 18, No. 2, 155-181, June 2006.

25. Peters, G.P., 2008. From production-based to consumption-based national emission inventories. *Ecological Economics,* Vol. 65, 13-23.

26. Rose, A., 1999. Input–output decomposition analysis of energy and the environment, in J.C.J.M. van den Bergh (ed.), *Handbook of Environmental and Resource Economics,* Edward Elgar, Cheltenham. pp. 1164–79.

27. Rose, A. and S.D. Casler, 1996. Input–output structural decomposition analysis: a critical appraisal, *Economic Systems Research*, 8 (1), 33–62.

28. Statistics Netherlands, 2007a. Milieurekeningen 2006. Heerlen/Voorburg

29. Statistics Netherlands, 2007b. National accounts 2006. Heerlen/Voorburg

30. Suh, S., G. Huppes and H. Udo de Haes, 2002. *Environmental impacts of domestic and imported commodities in the U.S. economy*, 14th International Conference on Input–Output Techniques, Montreal, Canada.

31. UN (United Nations), 2003. *System of integrated environmental and economic accounting 2003*, Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations & World Bank (2003). Final draft circulated for information prior to official editing, United Nations, New York.

32. WCED (World Commission on Environment and Development), 1987. *Our Common Future*, Oxford University Press, Oxford/New York.

33. Wilting, H., R. Hoekstra and S. Schenau, 2006. *Emissions and Trade; a Structural Decomposition Analysis for the Netherlands* Intermediate Input-Output Conference, 2006, Sendai, Japan

34. Wyckoff, A.W. and J.M. Roop, 1994. The embodiment of carbon in imports of manufactured products: implications for international greenhouse gas emissions, *Energy Policy*, (March), 187–94.

Annex. Some examples of tables in relation to environmental accounting, as presented in the national accounts publication (Statistics Netherlands, 2007b)

Economic key figures

	Unit	1990	1995	2000	2003	2004	2005*	2006*
Total economy								
Domestic product (GDP)	mln euro	243 652	305 261	417 960	476 945	491 184	508 964	534 324
Domestic product (GDP)	% volume changes	4,2	3,1	3,9	0,3	2,2	1,5	3,0
Burden of taxation and social security contributions	% GDP	41,7	40,0	39,7	37,2	37,3	37,6	39,1
National saving (net)	mln euro	26 729	37 791	57 368	49 831	61 913	57 285	67 896
National net lending/ net borrowing	mln euro	5 535	17 742	25 380	28 181	40 847	34 148	39 208
Change in financial net worth	mln euro	6 464	17 415	22 918	29 875	40 443	33 030	36 269
Environmental indicators								
Greenhouse effect (CO2-equivalents)	mln kg	229 448	245 311	242 117	244 903	248 393	243 862	238 801
Ozonelayer depletion (CFK11-equivalents)	1 000 kg	4 852	678	215	184	178	173	169
Acidification (AEQ)	mln kg	38	31	27	26	26	26	24
Eutrophication (EEQ)	mln kg	167	139	115	115	101	99	.
Waste (kg)	mln kg	14 982	9 209	4 907	2 750	1 836	.	.

Integrated physical Environmental accounts, 2004

	Greenhouse effect	CFKs and halons	Acidification	Fine dust (PM_{10})	Eutrophication total	Eutrophication to water	Heavy metal to water	Waste water	Dangerous waste	Non-dangerous waste
	mln kg CO_2 eq.	*1 000 kg*	*mln kg acid eq.*	*mln kg*	*mln kg manure eq.*		*heavy metal eq. (x 1000)*	*1 000 i.e.*	*mln kg*	
ORIGIN OF SUBSTANCES										
BY PRODUCERS	200 622	93,5	23,4	41,7	115	17	69,6	9 673	1 375	41 932
Agriculture, forestry and fishing	28 134	–	8,4	10,6	66	9	13,0	159	5	2 259
Mining and quarrying	3 322	–	0,1	0,1	0	0	0,2	9	14	274
Manufacturing	55 576	81,0	2,9	11,8	13	3	14,4	2 865	515	8 037
Manufacture of food products, beverages and tobacco	4 877	0,0	0,1	2,6	5	2	1,5	1 691	2	2 415
Manufacture of textile and leather products	301	–	0,0	0,1	0	0	0,8	103	8	56
Manufacture of paper and paper products	1 342	–	0,0	0,4	1	0	0,4	125	6	456
Publishing and printing	354	–	0,0	0,0	0	0	0,1	26	6	193
Manufacture of petroleum products	12 977	–	1,3	2,4	1	0	0,8	70	69	114
Manufacture of basic chemicals and man-made fibres	22 281	0,1	0,6	1,2	3	0	3,9	97	137	544
Manufacture of chemical products	715	–	0,0	0,4	1	0	0,5	440	78	285
Manufacture of rubber and plastic products	271	–	0,0	0,1	0	0	0,0	19	3	91
Manufacture of basic metals	7 437	0,0	0,4	2,2	0	0	0,8	40	129	2 272
Manufacture of fabricated metal products	781	–	0,0	0,6	0	0	0,8	48	30	120
Manufacture of machinery and equipment n.e.c.	382	–	0,0	0,0	0	–	0,1	43	9	76
Manufacture of electrical and optical equipment	500	–	0,0	0,1	0	0	1,5	41	15	62
Manufacture of transport equipment	278	0,0	0,0	0,0	0	0	2,7	35	11	97
Other manufacturing	3 082	80,9	0,3	1,7	1	0	0,2	87	13	1 257
Electricity, gas and water supply	56 804	–	1,3	0,4	1	0	0,2	28	11	1 406
Construction	2 073	12,5	0,4	2,1	4	0	0,8	60	56	23 694
Construction of buildings	550	–	0,1	0,6	4	0	0,3	.	.	.
Civil engineering	686	–	0,1	0,5	–	0	0,1	.	.	.
Building installation and completion	838	12,5	0,2	0,9	–	0	0,4	.	.	.
Trade, hotels, restaurants and repair	5 165	–	0,3	0,4	0	0	1,6	1 425	136	1 543
Trade and repair of motor vehicles/cycles	861	–	0,0	0,1	0	0	0,2	124	49	85
Wholesale trade (excl. motor vehicles/cycles)	1 703	–	0,1	0,2	0	0	0,6	218	84	404
Retail trade and repair (excl. motor vehicles/cycles)	982	–	0,0	0,1	0	–	0,6	298	3	706
Hotels and restaurants	1 619	–	0,0	0,0	–	0	0,2	786	0	348
Transport, storage and communication	29 399	–	8,9	13,7	9	0	5,4	198	157	333
Land transport	8 869	–	1,3	4,3	2	0	3,1	64	.	.
Water transport	7 435	–	6,1	7,9	5	–	1,7	6	.	.
Air transport	12 495	–	1,4	0,4	2	–	0,1	6	.	.
Supporting transport activities	355	–	0,0	1,1	0	0	0,4	101	.	.
Post and telecommunications	245	–	0,0	0,1	–	–	0,2	20	.	.
Financial and business activities	4 740	–	0,5	1,5	1	0	2,1	445	62	524
Banking	399	–	0,0	0,1	0	0	0,2	51	5	58
Insurance and pension funding	173	–	0,0	0,0	0	0	0,1	11	2	22
Activities auxiliary to financial intermediation	96	–	0,0	0,0	0	0	0,1	18	2	21
Real estate activities	229	–	0,0	0,0	0	0	0,1	171	2	27
Renting of movables	1 834	–	0,2	0,8	0	0	0,4	13	3	9
Computer and related activities	293	–	0,0	0,1	0	0	0,2	9	4	47
Research and development	232	–	0,0	0,0	0	0	0,1	9	2	12
Legal and economic activities	661	–	0,0	0,1	0	0	0,3	162	8	99
Architectural and engineering activities	189	–	0,0	0,0	0	0	0,1	–	3	38
Advertising	106	–	0,0	0,0	0	0	0,1	–	2	20
Activities of employment agencies	206	–	0,0	0,1	0	0	0,3	–	8	100
Other business activities	321	–	0,0	0,1	0	0	0,2	–	20	72
General government	3 381	–	0,4	0,6	0	0	2,6	308	35	330
Public administration and social security	1 495	–	0,1	0,2	0	–	2,1	118	13	166
Defence activities	815	–	0,2	0,4	–	0	0,1	8	11	28
Subsidized education	1 070	–	0,0	0,0	0	–	0,4	183	11	136
Care and other service activities	12 028	–	0,3	0,4	20	6	29,3	4 176	383	3 532
Health and social work activities	2 280	–	0,1	0,0	0	0	13,4	654	36	338
Sewage and refuse disposal services	7 898	–	0,1	0,2	20	5	15,5	3 024	333	3 051
Recreational, cultural and sporting activities	1 148	–	0,0	0,1	0	–	0,2	306	4	50
Private households with employed persons	–	–	–	–	–	–	0,1	2	2	31
Other service activities n.e.c.	703	–	0,0	0,1	–	0	0,2	190	8	63
BY CONSUMERS	39 922	61,7	2,1	10,5	26	16	76,7	16 282	292	8 607
OTHER DOMESTIC ORIGIN	7 559	23,0	0,0	0,0	5	6	6,1	4 460	.	.
Total residents	248 393	178,2	25,6	52,2	145	39	152,4	30 415	1 667	50 540
FROM THE REST OF THE WORLD			9,3	.	51	44	352,4	.	490	130
Total origin of substances	248 393	178,2	34,9	52,2	196	83	504,8	30 415	2 157	50 669
DESTINATION OF SUBSTANCES										
ABSORPTION BY PRODUCERS					33	23	90,2	26 837	1 452	44 932
TO THE REST OF THE WORLD			20,8	.	59	42	220,9	.	322	4 285
CONTRIBUTION TO ENVIRONMENTAL THEMES										
Greenhouse effect	248 393									
Ozonelayer depletion		178,2								
Acidification			14,1							
Air pollution				52,2						
Eutrophication					103					
Water pollution						18	193,7	3 578		
Waste									384	1 452
Total destination of substances	248 393	178,2	34,9	52,2	196	83	504,8	30 415	2 157	50 669

Integrated monetary Environmental accounts, 2004

	Output (basic prices)	Value added (gross, basic prices)	Environ-mental costs	Green taxes	Environ-mental taxes	Labour input of employed persons
	mln euro					*1 000 full-time equivalent jobs*
BY PRODUCERS	913 856	436 874	.	5 938	890	6 480
Agriculture, forestry and fishing	23 248	9 399	740	207	48	216
Mining and quarrying	14 835	11 324	122	28	3	9
Manufacturing	223 873	62 594	1 300	740	258	865
Manufacture of food products, beverages and tobacco	47 633	11 571	180	116	117	123
Manufacture of textile and leather products	3 781	1 092	x	11	14	21
Manufacture of paper and paper products	5 579	1 664	39	17	13	23
Publishing and printing	12 674	5 647	23	27	7	80
Manufacture of petroleum products	18 763	2 641	277	222	5	6
Manufacture of basic chemicals and man-made fibres	29 086	7 257	358	89	19	30
Manufacture of chemical products	12 134	3 162	89	28	22	35
Manufacture of rubber and plastic products	6 103	1 898	15	17	3	32
Manufacture of basic metals	7 042	2 306	100	30	11	21
Manufacture of fabricated metal products	14 478	4 769	41	38	8	93
Manufacture of machinery and equipment n.e.c.	17 168	5 597	33	35	6	84
Manufacture of electrical and optical equipment	18 595	3 869	39	22	9	82
Manufacture of transport equipment	13 970	3 410	22	18	3	50
Other manufacturing	16 867	7 711	x	71	21	185
Electricity, gas and water supply	24 985	6 757	200	83	15	29
Construction	63 675	23 501	.	199	29	450
Construction of buildings	31 303	10 031	.	60	7	172
Civil engineering	12 285	4 108	.	33	5	76
Building installation and completion	20 087	9 362	.	107	17	202
Trade, hotels, restaurants and repair	116 523	65 832	.	672	130	1 238
Trade and repair of motor vehicles/cycles	14 875	7 416	.	196	11	133
Wholesale trade (excl. motor vehicles/cycles)	58 467	33 851	.	301	37	428
Retail trade and repair (excl. motor vehicles/cycles)	26 985	16 294	.	118	29	484
Hotels and restaurants	16 196	8 271	.	58	53	193
Transport, storage and communication	68 685	32 303	149	1 067	62	410
Land transport	17 377	9 865	.	896	8	180
Water transport	5 683	1 828	.	45	1	20
Air transport	7 514	1 958	.	20	33	28
Supporting transport activities	13 957	6 408	.	58	13	87
Post and telecommunications	24 154	12 244	.	48	7	94
Financial and business activities	209 440	117 839	.	2 244	87	1 282
Banking	35 721	19 025	.	75	8	139
Insurance and pension funding	17 674	8 957	.	42	4	52
Activities auxiliary to financial intermediation	5 990	4 239	.	24	2	54
Real estate activities	53 307	32 608	.	33	24	68
Renting of movables	7 652	4 243	.	1 775	6	23
Computer and related activities	14 110	8 062	.	39	6	114
Research and development	3 714	1 941	.	25	2	30
Legal and economic activities	28 999	15 215	.	105	12	243
Architectural and engineering activities	9 963	4 845	.	26	5	93
Advertising	6 583	2 022	.	17	2	50
Activities of employment agencies	11 535	9 361	.	21	3	243
Other business activities	14 192	7 321	.	61	13	172
General government	79 809	51 436	.	347	69	800
Public administration and social security	48 759	27 824	.	257	48	404
Defence activities	6 480	4 200	.	29	0	65
Subsidized education	24 570	19 412	.	61	21	332
Care and other service activities	87 558	55 889	.	352	189	1 180
Health and social work activities	52 435	38 722	.	105	85	805
Sewage and refuse disposal services	7 749	2 866	2 318	128	59	27
Recreational, cultural and sporting activities	15 642	6 245	.	76	30	121
Private households with employed persons	1 921	1 921	.	0	0	75
Other service activities n.e.c.	9 811	6 135	.	43	15	153
BY CONSUMERS			307	10 126	2 693	
Total	913 856	436 874	.	16 064	3 583	6 480

Regional Climate Change Scenarios for South America-The CREAS project

Jose A. Marengo
CPTEC/INPE
Rodovia Dutra km. 40, 12630-000 Cachoeira Paulista, São Paulo, Brazil
Tel +55 12 3186 8464, Fax +55 12 3101 2835
Email: marengo@cptec.inpe.br

1. Introduction

In this study we focus on the application of the Regional Climate Models (RCM), the main dynamical downscaling technique. RCMs represent an effective method of adding fine-scale detail to simulated patterns of climate variability and change as they resolve better the local land-surface properties such as orography, coasts and vegetation and the internal regional climate variability through their better resolution of atmospheric dynamics and processes. Downscaling experiments on climate change scenarios in South America have also shown a reduction of rainfall in Amazonia as well as an small increase in rainfall in various regions of South America during 2071-2100 for the SRES A2 and B2 scenarios (Marengo and Ambrizzi 2006, Marengo et al 2007, Nuñez at al. 2006, Solman and Nunez 2007). On climate extremes, studies by Marengo et al. (2008) derived from regional models have shown an increase in the frequency of dry spells in tropical South America East of the Andes, warm nights in all South America as well as an increase in rainfall extremes in Southeastern South America by the end of the XXI Century. This is in agreement with global models projections on extremes from IPCC AR4 global models by Tebaldi et al. (2006).

Despite the concerns raise above about their resolution, initial analysis of the effect of climate change in South America extremes has been carried out using GCMs. The Chapter 10 on Regional Climate Change projections from the IPCC AR4 (Meehl et al. 2007 and references quoted in) shows a nice summary of studies on climate change projections in South America. The analysis of the climate change projections for the A1B scenario made by Vera et al. (2006) show a substantial agreement among IPCC-AR4 models in precipitation changes for the period 2070-2099 relative to 1970-1999, mainly characterized by an increase of summer precipitation over the northern Andes and southeastern South America, while over the Amazon results are mixed. This is also confirmed Li et al. (2006) using IPCC AR4 GCMS. On air temperature changes, Meehl et al (2007) shows that all models feature warming in South American with the strongest warming being in tropical South America, especially Amazonia and Northeast Brazil, reaching in some models increases of up to 6-8^{o}C warmer than the present by 2100, and with the degree of warming varying among models.

The issue of the spatial resolution in scenarios must be put in the context of other uncertainties of climate change. Studies and analyses of climate change impact and adaptation assessments recognize that there are a number of sources of uncertainty in such studies which contribute to uncertainty in the final assessment. The importance of high resolution climate scenarios for impacts and adaptation studies remains to be thoroughly explored in South America. High resolution scenarios developed from regional climate model results have been obtained in various parts of the world, and review is found in Marengo et al. (2008).

In Europe and North America several national and international projects have used RCMs to help quantify better regional climate change and provide regional climate scenarios for assessing climate change impacts and vulnerability. This include the UK

Climate Impacts Programme (Hulme et al., 2002), the European Project PRUDENCE (Christensen et al. 2006) in the North American project NARCCAP (Mearns et al. 2004). These have all followed a standard experimental design of using one or more GCMs to drive various regional models from meteorological services and research institutions in the regions to provide dynamically downscaled regional climate projections. Typically, a present day (e.g. 1960-1990) and a future climate (2070-2100) time slices are simulated to calculate changes in relevant climatic variables.

A similar initiative has been recently implemented in South America, CREAS (*Regional Climate Change Scenarios for South America* – Marengo and Ambrizzi 2006, Marengo et al. 2007). It aims to provide high resolution climate change scenarios in South America for raising awareness among government and policy makers in assessing climate change impact, vulnerability and in designing adaptation measures. CREAS runs three regional models nested in HadAM3P (a GCM used in PRUDENCE): WS Eta for Climate Change Studies – Eta CCS workstation version-(Pisnitchenko et al. 2006, Pisnitchenko and Tarasova 2007), RegCM3 (Ambrizzi et al. 2007) and HadRM3P (Jones et al., 2004, Marengo et al. 2008). CREAS will explore issues such as: the challenge of using regional climate projections to develop plausible scenarios for future changes at daily time scales for extreme events; an assessment of current methods of scenario development for regions where data is available; assessments of vulnerability in regions and key sectors in South America.

In this paper, we show some of the regional climate change in South America as produced by an ensemble of the 3 regional models from he CREAS project. This paper focuses on the analyses of two 30-year simulations: the present climate that examines the time period 1961–1990 and the future climate that covers the time slice of 2071–2100 under the IPCC SRES (Special Report on Emissions Scenarios) A2-high emission and B2-low emission scenarios.

2. Methodology, models and experiments

Global model

The RCM integrations analyzed in this study were conducted by nesting into the atmosphere-only GCM (HadAM3P) of the Hadley Centre at the U.K. Met Office. The experimental design of the driving HadAM3P experiment is described by Rowell (2005) and is summarised as follows. The HadAM3P 1961-1990 simulation is forced by observed sea-surface temperatures and sea-ice (SSTs) from the HadISST1 dataset (Rayner et al., 2003). For the future period, 2071-2100, HadAM3P is forced by SSTs which are formed from observed SSTs with the addition of mean changes and trends calculated a global coupled model projection. For the future, sea surface conditions were constructed from observations and anomalies from a transient integration of HadCM3 using the IPCC SRES A2 and B2 emission scenarios for the SRES scenarios A2 and B2 (Nakicenovic et al., 2000). The coupled integration was performed with HadCM3 (Gordon et al., 2000) whose atmospheric component, HadAM3 (Pope et al., 1999), is the basis for HadAM3P (Jones et al., 2007). The same SSTs were used as the lower boundary condition for the HadRM3P simulations. The HADAM3P integrations, from which the forcing fields for the RCMs were taken, have a resolution of about 1.25° latitude by 1.875° longitude and they extend over the two present and future time slices.

Regional models

In CREAS three RCMs with resolution of about 50 km over South America have been used to simulate the years 1961-1990 (present) and 2071-2100 (future).

1. HadRM3P, used by the UK Met Office-Hadley Centre. This model was developed, along with its parent GCM HadAM3P (Jones et al., 2004), to provide realistic simulation of regional climate globally. The main changes are related to calculation of large-scale cloud and assumptions about the radiative effects of convective clouds. Consequent changes were made to parameters in the precipitation scheme relating to precipitation efficiency to ensure reasonable vertical cloud profiles, cloud forcing and radiation fields.

2. WS Eta CCS, used by CPTEC/INPE in Brazil. This workstation version of the Eta model was developed by NCEP [a previous version of it is being used at CPTEC/INPE for weather and climate forecasts], and some modifications were made Pisnichenko et al, (2006) and Pisnichenko and Tarasova (2007) to make it suitable for climate change studies.

3. RegCM3, used by the University of Sao Paulo, Brazil. This models is a modified version of the MM4 (Mesoscale Model version 4), and the main modifications and adaptations in this for its use in climate change studies are described in Giorgi et al. (2001).

Only two GHG concentration scenarios from IPCC-SRES have been used in CREAS, namely A2 and B2. In this study, the seasonal mean responses are calculated as the difference between the mean 2071- 2100 and 1961-1990 for each grid point of a common grid (0.5°x0.5°) covering the domain common to all RCMs. Therefore all results about response and uncertainty could be displayed on maps over South America between 15 N-50 °S, 25-90 °W. The three RCMs ran for only one (but the same) pair of ensemble members.

3. Results

In the following we discuss the mean climatic features of climate change projections for both A2 and B2 scenarios for 2071-2100 produced by the ensemble of the 3 regional models (Fig. 1). These projections were derived from the downscaling of the HadAM3 global model by the Eta CCS, RegCM3 and HadRM3P regional models, as documented in Ambrizzi et al. (2007) and Marengo et al. (2007). In the Amazon region, for the B2 scenario, air temperatures may increase between 3-4 ^{o}C and rainfall may reduce by 5-20% in eastern Amazonia, as compared to the present. In Northeast Brazil these changes can vary from 1-4^{o}C of warming with rainfall reductions of between 10-15%. For A2 the possibility of even larger changes is indicated (reaching up to 8^{o}C and 40% drier in both eastern Amazonia and Northeast Brazil). Small increases of rainfall in southern Brazil and northern Argentina in the future can reach 5-10%, relative to the 1961-90 under the A2 and B2 scenarios.

A) B2, rainfall anomalies (mm/day)	B) A2, rainfall anomalies (mm/day)

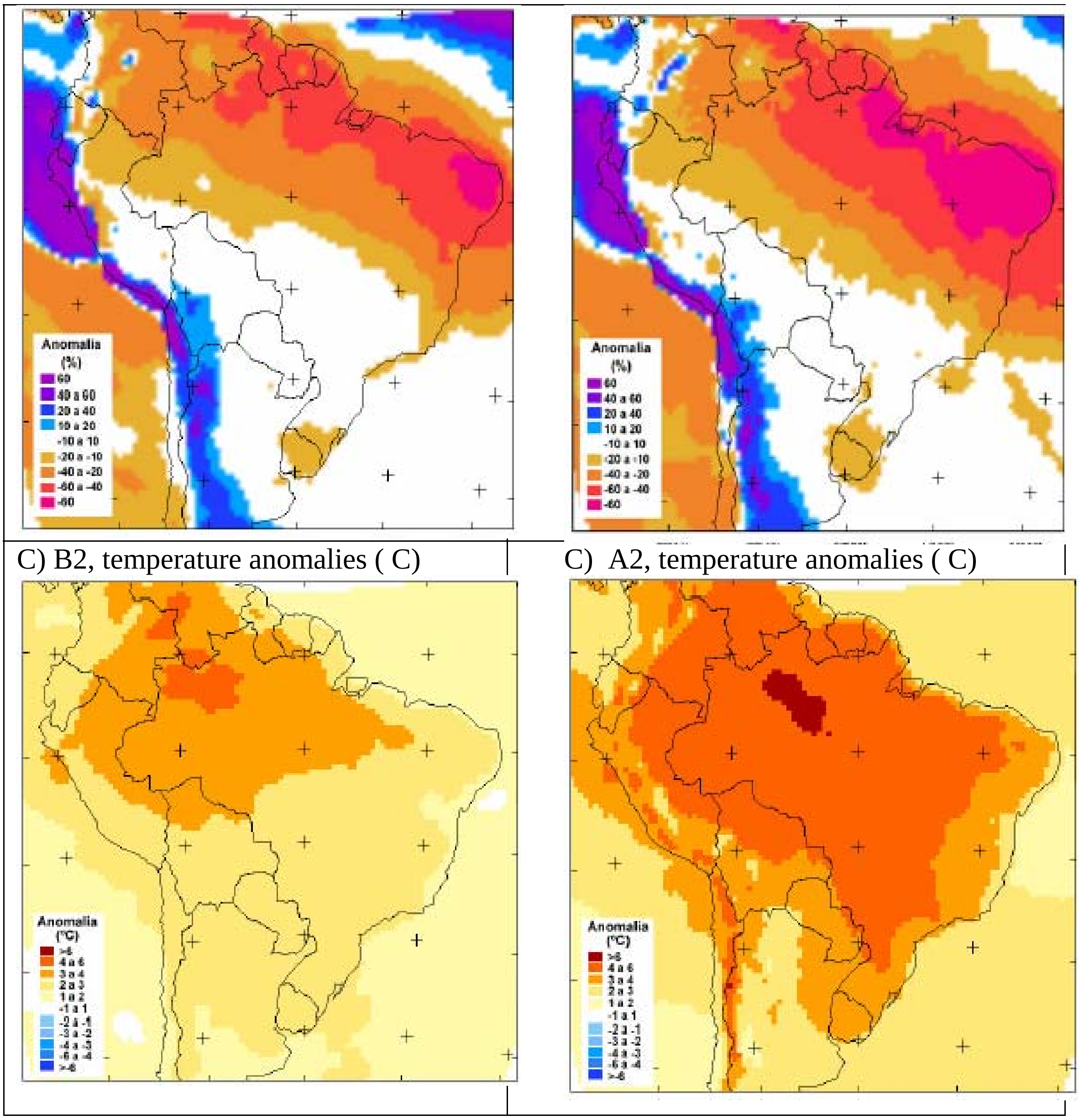


Figure 1. Projections of annual rainfall (mm/day) and air temperature anomalies (^{o}C) for both A2 and B2 scenarios for 2071-2100 relative to 1961-90, as produced by the ensemble of the 3 regional models: Eta CCS, RegCM3 and HadRM3P regional models

A recent study (Marengo et al. 2008) documents projections of extreme rainfall events in South America in warmer climates, using various extreme indices considered in the IPCC AR4. Using the PRECIS regional climate modeling system, this study analyzes the distribution of extremes of temperature and precipitation in South America in the recent past (1961-1990) and in a future (2071-2100) climate under the IPCC SRES A2 and B2 emissions scenarios. The results show that for the present climate the model simulates well the spatial distribution of extreme temperature and rainfall events when compared with observations, with temperature more realistic. The observations over the region are far from comprehensive which compromises the assessment of model quality. In all the future climate scenarios considered all parts of the region would experience significant and often different changes in rainfall and temperature extremes. In the future the occurrence of warm nights is projected to be more frequent in the entire tropical South America, while the occurrence of cold night events is likely to decrease. Significant changes in rainfall extremes and dry spells are also projected. These include increased intensity of extreme precipitation events over most of Southeastern South America and western Amazonia consistent with projected increasing trends in total rainfall in these regions. In Northeast Brazil and eastern Amazonia, smaller or no changes are seen in projected rainfall intensity though significant changes are seen in the frequency of consecutive dry days

Based on the projections for climate change in the future, and also on the projections for extreme rainfall and temperature events until the end of the XX Century, Figure 2 summarized possible impacts of climate change in Brazil. Different regions show different vulnerabilities. While in almost of Brazil the natural ecosystems would be affected, Southern and Southeastern Brazil seem to cope the impacts of climate change, while regions as Northeast Brazil would experience the highest vulnerability, especially on the social side. This region is vulnerable to the extremes of climate variability in present climates (e.g. drought during El Nino years). The different Brazilian states that are parte of the Northeast region exhibit lower indicators of social and health conditions, as well as lower human development index, and in future climate a tendency for aridization would exacerbate the social vulnerability.

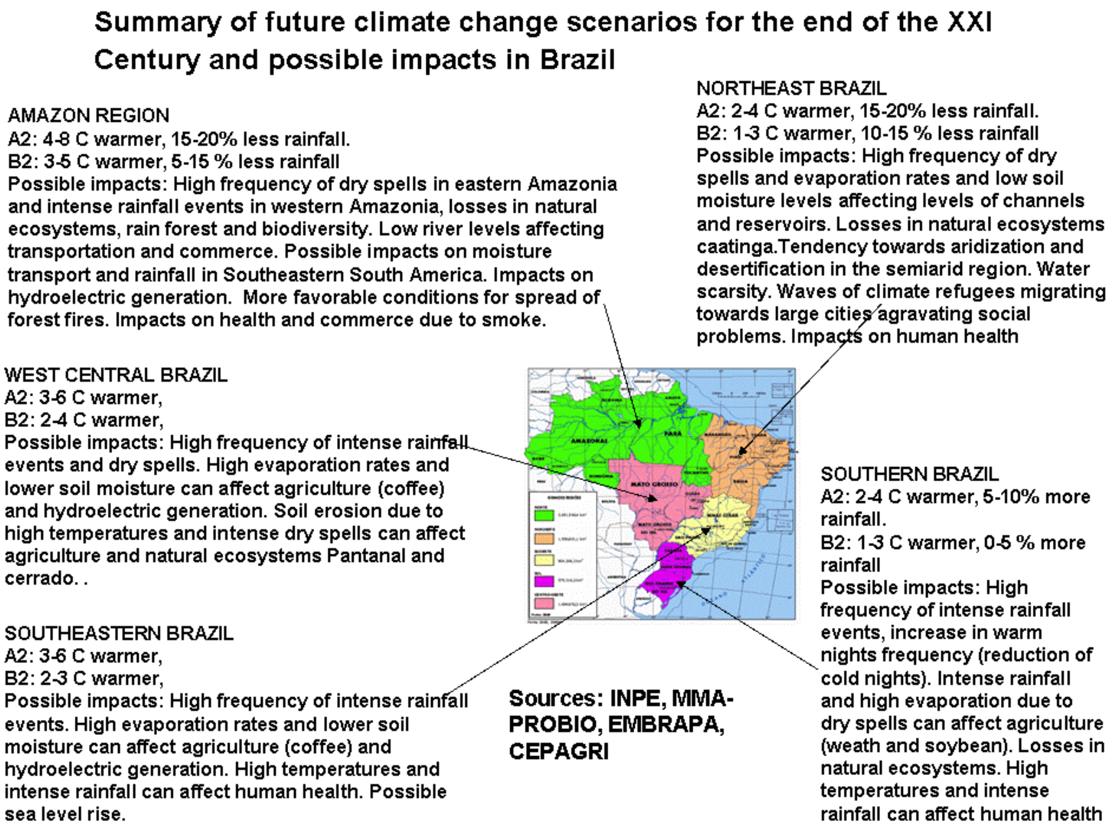


Figure 2. Summary of regional climate change projections for Brazil, for both A2 and B2 scenarios, as expected impacts in various political regions of Brazil.

4. Discussions

As it was shown in PRUDENCE, the largest source of uncertainty in the regional simulations was the choice of global model. The CMIP3 models have shown little coherence over tropical South America (Christensen et al. 2007), and future responses in precipitation, particularly over tropical South America, vary widely. We acknowledge that if the purpose is to provide information on extremes for impact studies, then the use of a single global model for downscaling is wholly inadequate. The rationale for the choice of global model HadAM3P was because of: (a) the model seems to reproduce quite well seasonal distribution and variability of rainfall y large areas of South America, even though some systematic errors, (b) at the time was the only global model available with the time resolution (every 6 hours) for dynamic downscaling experiments, and (c) its has been investigated quite thoroughly in various regions of the planet in previous downscaling experiences, as in PRUDENCE, NAARCAP and some of the CREAS simulations.

Future work will include the use of other regional models for the downscaling of improved versions of the HadCM3 future scenarios, and also we plan to use other global models. It is clear that a dynamic downscaling experiment would be much stronger if one regional model was nested in more than one global model, and the added value will be improved if additional global forcing is contemplated. Currently we at INPE are working on the dynamic downscaling of an ensemble of runs of the HadCM3 and the ECHAM 4 using the Eta model at 40 km resolution for 1960-2100, and not just 2071-2100 as in the PRECIS type experiments. This will provide estimates of likely ranges of future climate changes.

Another crucial area of future work is to improve access to data from and increase the observational network in tropical South America so the model can be validated for these regions. The limitations of the observational network are clearly evidenced in Marengo et al. (2008). Large areas of tropical South America do not show comprehensive, homogeneous and high quality data. Currently, some meteorological services in South America are performing a major task of digitalizing and checking climate series that are currently on paper form and tapes. New initiatives are being proposed to build a consolidate hydrometeorological data bank in Amazon countries, organized by the Amazon Cooperation Treaty, and in Southern South America as part of the CLARIS EU project. The idea is to provide high quality data for South America for trend analyses that would be useful for the computation of indices of extremes, as those defined by Frisch et al. (2002) and new ones that are being implemented by IPCC for the Fifth Assessment Report. This well help in understanding the reasons for observed changes in climate extremes and in improving confidence in projected changes.

Acknowledgements:

CREAS is funded by MMA/BIRD/GEF/CNPq (PROBIO Project) from the Brazilian Ministry on the Environment MMA, the Brazilian National Climate Change Program from the Ministry of Science and Technology MCT, the UK Global Opportunity Fund-GOF Project Using Regional Climate Change Scenarios for Studies on Vulnerability and Adaptation in Brazil and South America, the GEOMA, the LBA2 Millennium Institute and the CLARIS-EU project.

References:

Ambrizzi, T., R. Rocha, J. A., Marengo, I. Pisnitchenko, L. and Alves, (2007) Cenários regionalizados de clima no Brasil para o Século XXI: Projeções de clima usando três modelos regionais. Relatório 3, MINISTÉRIO DO MEIO AMBIENTE - MMA, SECRETARIA DE BIODIVERSIDADE E FLORESTAS –SBF, DIRETORIA DE CONSERVAÇÃO DA BIODIVERSIDADE – DCBio Mudanças Climáticas Globais e Efeitos sobre a Biodiversidade - Sub projeto: Caracterização do clima atual e definição das alterações climáticas para o território brasileiro ao longo do Século XXI. Brasília, Fevereiro 2007.

Christensen, J. H., T. R. Carter, and M. Rummukainen (2006) Evaluating the performance and utility of regional climate models: The PRUDENCE project, Clim. Change, in press.

Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr and P. Whetton, 2007: Regional Climate Projections. In: Climate Change 2007:The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Giorgi, F., B. Hewitson, J. Christensen, M. Hulme, H. Von Storch, P. Whetton, R. Jones, L.Mearns, C. Fu, (2001) Regional Climate Information: Evaluation and Projections (Chapter 10). In *Climate Change 2001: The Scientific Basis, Contribution of Working Group I to the Third Assessment Report of the IPCC* [Houghton, J. T., Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, and C. A. Johnson (eds.)]. Cambridge U. Press: Cambridge, pp. 739-768.

Gordon, C., C. Cooper, C. A. Senior, H. Banks, H. M. Gregory, T. C. Johns, J. F. B. Mitchell, and R. A. Wood (2000) The simulation of SST, sea ice extent and ocean heat transports in a version of the Hadley Centre coupled model without flux adjustments, Clim. Dyn., 16, 147– 168.

Hulme M, Jenkins G J, Lu X, Turnpenny J R, Mitchell T D, Jones R G, Lowe J, Murphy J M, Hassell D, Boorman P, Macdonald R, Hill S (2002) Climate-Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report. Tyndall Centre for Climate Change Research. School of Environmental Sciences. University of East Anglia, Norwich, UK, 120pp

Jones, R. G., M. Noguer, D. Hassell, D. Hudson, S. Wilson, G. Jenkins, and J. Mitchell (2004) Generating high resolution climate change scenarios using PRECIS, report, Met Off. Hadley Centre, Exeter, UK.

Jones RG, Murphy JM, Hassell DC, Woodage MJ (2007) A high resolution atmospheric GCM for the generation of regional climate scenarios. Submitted to Climate Dynamics

Li, W., R. Fu, and Dickinson RE (2006) Rainfall and its seasonality over the Amazon in the 21st century as assessed by the coupled models for the IPCC AR4. *J. Geophys. Res.*, **111**, D02111, doi:10.1029/ 2005JD006355.

Marengo, J., T. Ambrizzi, (2006) Use of regional climate models in impacts assessments and adaptations studies from continental to regional and local scales: The CREAS (Regional Climate Change Scenarios for South America) initiative in South

America. Proceedings of 8 ICSHMO, Foz do Iguaçu, Brazil, April 24-28, 2006, p. 291-296.
Marengo, J. A., L. Alves, M., Valverde, R., Rocha, and R., Laborbe, (2007) *Eventos extremos em cenários regionalizados de clima no Brasil e América do Sul para o Século XXI: Projeções de clima futuro usando três modelos regionais*. ***Relatório 5***, Ministério do Meio Ambiente - MMA, Secretaria de Biodiversidade e Florestas – SBF, Diretoria de Conservação da Biodiversidade – DCBio Mudanças Climáticas Globais e Efeitos sobre a Biodiversidade - Sub projeto: Caracterização do clima atual e definição das alterações climáticas para o território brasileiro ao longo do Século XXI. Brasília, Fevereiro 2007
Marengo, J, Jones, R. Alves, Valverde, M., (2008) Future change of temperature and precipitation extremes in South America as derived from the PRECIS regional climate modeling system, submitted to Int. J. Climatology.
Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao, 2007: Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
Mearns, L. (2004) NARCCAP North American Regional Climate Change Assessment Program A Multiple AOGCM and RCM Climate Scenario Project over North America. 12/17/2004. AGU Fall Meeting, San Francisco, USA.
Nakicenovic N, Alcamo J, Davis G, de Vries B, Fenhann J, Gaffin S, Gregory K, Grubler A, Jung TY, Kram T, La Rovere EL, Michaelis L, Mori S, Morita T, Pepper W, Pitcher H, Price L, Riahi K, Roehrl A, Rogner H-H, Sankovski A, Schlesinger M, Shukla P, Smith S, Swart R, van Rooijen S, Victor N, Dadi Z (2000) Special report on emissions scenarios Cambridge 599pp
Nuñez, M. S. Solman and M. F. Cabré, (2006) mean climate and annual cycle in a regional climate change experiment over Southern South America. II: Climate change scenarios (2081-2090), Proceedings of 8 ICSHMO, Foz do Iguaçu, Brazil, April 24-28, 2006, p. 325-331.
Pisnitchenko, I.A., T.A. Tarasova (2007), The new version of the Eta regional model developed for climate-change simulations. Submitted to Meteorological Applications, 2007.
Pope, V. D., M. L. Gallani, P. R. Rowntree, and R. A. Stratton (1999) The impact of new physical parametrizations in the Hadley Centre climate model: HadAM3, Clim. Dyn., 16, 123–146.
Rowell, D. P. (2005) A scenario of European climate change for the late twenty-first century: Seasonal means and interannual variability, Clim. Dyn., 25, 837– 849, doi:10.1007/s00382-005-0068-6.
Solman, S, M. N. Nuñez, M. F. Cabre (2007) Regional climate change experiments over southern South America. I: present climate, Clim Dyn, DOI 10.1007/s00382-007-0304-3
Tebaldi, C., K. Hayhoe, J. Arblaster, G. Meehl, (2006) Going to the extremes: An intercomparison of model-simulated historical and future changes in extreme events. *Climatic Change*, 79: 185–211 DOI: 10.1007/s10584-006-9051-4
Vera,C., G. Silvestri, B. Liebmann, P. González, (2006) Climate change scenarios for seasonal precipitation in South America from IPCC-AR4 models. Gephys. Res, Lett, . 33, L13707, doi:10.1029/2006GL025759, 2006.

Macroeconomic modelling for energy and environmental analyses
Integrated economy-energy-environment models as efficient tools

Brita Bye[1]

Abstract

Integrated economy-energy-environment modelling has a long tradition in Norway. Early development of energy and environment statistics made it possible to develop computable multisectoral general equilibrium models (CGE-models) with a rigorous description of energy supply and demand, and the interlinkages between economic activity, energy production and use, and emissions to air. These integrated CGE-models have been used for forecasting purposes and numerous analyses of energy and environmental policies during the last two decades. Especially the models have been developed to be suitable for analysing different economic policy options to deal with the global climate issue as design of optimal carbon tax or carbon quota schemes.

Preliminary version – Please do not quote without permission

[1]Ph.D. , Senior Research Fellow, Research Department, Statistics Norway. Email: Brita.Bye@ssb.no

1. Introduction

Norway has a long tradition in building and using disaggregated multisectoral general equilibrium models for policy purposes. The tradition goes back to the work of Leif Johansen (1960, 1974). The work has mainly been carried out by the Research Department of Statistics Norway. Over time energy and emission modules have been integrated in the economic core model, allowing for consistent analyses of economic, energy and environmental issues based on one and same modelling framework. The extended modelling tool has been extensively used by the government of Norway for making forecasts of economic development, energy demand and emissions to air from the early 1980-ties up to now. The Ministry of Finance (2004) is a recent example.

Integrated economy-energy-environment modelling has a long tradition in Norway, see Alfsen et al (1996) and Alfsen (1997) for a listing of earlier applications. Early development of energy and environment statistics made it possible to develop computable multisectoral general equilibrium models (CGE-models) with a rigorous description of energy supply and demand, and the interlinkages between economic activity, energy production and use, and emissions to air. Environmental effects are in most cases closely related to economic activities. Interlinking these effects through integrated economy-energy-environment models is a large step in the necessary direction for making consistent economy and environmental projections. These integrated CGE-models have been used for forecasting purposes and numerous analyses of energy and environmental policies during the last two decades. Bye et al (1989) and Moum et al (1992) present early analyses of policy options within the field of economic policy, industrial development and environmental concerns. Moum et al (1992) emphasized climate change issues. Åvitsland (2006) is a recent analysis for the Norwegian Low Emission Commission. During the last 15 years the models have been further developed to be suitable for analysing different economic policy options to deal with the global climate change issue as design of optimal carbon taxation or carbon quota schemes.

These so-called top-down interlinked economy-energy-environmental models give a consistent framework both for forecasting issues and for analyses of policy issues and evaluation of economic, energy and environmental policies, without explicitly including the environment in the objective function. They have contributed to enhance the understanding of environmental issues as economy wide by the economists, and broadened the environmental activists' views in the public debate that environmental issues have economic effects. The interlinked models provide us with consistent calculations of economic efficiency effects of different policy means, and calculate the economic costs of different policy means.

Environmental policy goals can be both national and/or specified by an international environmental agreement as the Gothenburg protocol or the Kyoto protocol (emission reductions, emission standards etc.). The forecasts generated by the models are used to evaluate whether the emission targets will be reached. In addition the models are used for analyses of different policies options to reach the environmental commitments.

Many of the environmental problems develop slowly and the economic costs will be stronger in the far future than in the present. Emissions of greenhouse gases cause environmental problems with highly uncertain costs in the far future, but poses questions of early policy actions. There is a need for intertemporal models with endogenous accumulation of labour and capital to evaluate such long term policies.

There have been some attempts for including so-called environmental feed-back effects as local health and corrosion effects, into these interlinked models, Alfsen et al (1992) and Rosendahl (1998). Such calculations are mostly based on different data sources and methods than the tradition National Accounts. The measures are often uncertain, maybe more uncertain than the other parts of the model. It is also difficult to measure all the feed-back effects such that the estimated costs or benefits will often become highly underestimated. From the model users and policy recommendations point of view it may be better not to include any such feed-back effects than to only include some very uncertain measures. The communication of the results will often be more transparent if all such effects are left out.

Technological change is typically modelled as factor augmenting and exogenous in these models, implying that technological change is not altered by different policies. Recently there have emerged numerical CGE models that models technological change. Early examples are Goulder and Schneider (1999), Popp (2004) and Otto et al (2006). How environmental policies influence creation of new and more environmental friendly technologies, how to stimulate adoption of new and better technologies and how environmental policies interlinks with innovation policies are analysed in these new models. Heggedal and Jacobsen (2008) presents a Norwegian analysis of optimal time paths for subsidies towards domestic production of Research and Development (R&D) for a given costs of carbon emissions. This study is part of a large research project that analyses technological change and interlinkages between innovation and environmental policies at the Research Department, Statistics Norway.[2]

Economic statistics are encumbered with some uncertainty and environmental statistics is often regarded as more uncertain. One source of uncertainty are the statistics, other sources of uncertainty in the integrated models are the economic modelling, parameter values etc. Integrating the two sources

[2] The project is financed by the Norwegian Research Council's programmes SAMSTEMT and RENERGI.

of data through economy-energy-environmental models implies that the models are encumbered with uncertainty and will generate results that should be viewed with critical eye. This is not an argument against establishing such models and using them for policy purposes, though. Rather, the consistent framework they provide in the policy discussion is valuable, even if the results are uncertain. It is though important to perform sensitivity analyses of the model and the parameter values in order to present the distribution of uncertainty in the results of different policy analysis.

Environmental problems are often complex and detailed modelling are necessary to give a proper description. In the interlinked model context there is a trade off between transparency and detail- and correctness. The costs of not giving the most correct description of a complex economic-environmental structure must be weighed against the costs of having a too disaggregated and complicated model structure that is difficult to interpret.

This presentation develops as follows: Section 2 briefly outlines the structure of the Statistics Norway's recent numerical macroeconomic disaggregated general equilibrium model MSG-6, section 3 focuses on the emissions module of the model and the calibration to relevant statistics, while section 4 briefly presents a projection and some examples of policy analyses. Section 5 makes concluding remarks and points to some issues for future developments of the statistics and the applied integrated economy-energy-environment models.

2. The general equilibrium model

The computable general equilibrium model of the Norwegian economy, MSG-6, is a dynamic, integrated economy and emission model, designed for studies of economic and environmental impacts of energy and environmental policy.[3] Especially the model has been used for several different climate policy analyses. The model specifies 60 commodities and 40 industries, classified with particular respect to capture important substitution possibilities with environmental implications. The model gives a detailed description of governmental taxes and transfers as environmental policy, trade policy, subsidies, tax rates, and real government spending. Since the Norwegian economy is small and the exchange rate is normalised to unity, all agents face exogenous world market prices and interest rates. Thus, financial capital is perfectly mobile across borders. Real capital and labour are domestically mobile. The latest version of the model is calibrated on the basis of the National Accounts for 2004 and relevant micro-econometric studies. Bye (2000a) provides a more detailed description of the model.

[3] This presentation is based on the presentation in Bruvoll et al (2003).

Household behaviour

Households are rational and forward-looking, and determine their consumption and savings by maximising welfare over an infinite horizon. The aggregate consumption profile and thus the scale effect on emissions from households, result from the combination of consumption smoothing and consumption substitution across time according to the relative costs of living and intertemporal substitution. The intratemporal utility function has a detailed nested translated CES structure (19 consumer goods and services), which reflects relevant price-induced substitution possibilities and distinguishes between activities with different pollution profiles (see Appendix 1, Figure A1). It forms the main basis for the potential composition effects on emissions from consumption. Aasness and Holtsmark (1995) and Strømsheim Wold (1998) give parameter estimates of the substitution- and Engel elasticities. External effects, and in particular repercussions from the environment to the utility of the household, are not explicitly modelled.

Market Structure and Producer Behaviour

Changes in emissions from firms in the private business sector are determined by firms' input and output decisions. Firms are run by rational, forward-looking managers who maximise the net present value of the cash-flow to owners. The commodities produced in primary industries are homogenous and traded in perfectly competitive markets. In the domestic markets for manufacturing goods and services, which constitute the main part of the economy, the firms face monopolistic competition. As in most models in the CGE tradition, all goods, services and factors are perfectly mobile across industries within the economy, and supply equals demand in all markets in all periods. The demand for inputs is derived from industry-specific nested structures of linearly homogeneous CES-functions (see Appendix 1, Figure A2). Most elasticities of substitution are set in accordance with estimates presented in Alfsen, Bye and Holmøy (1996) and Andreassen and Bjertnæs (2006).

Trade

Imported services and manufactured goods are close, but imperfect substitutes for the domestically supplied products. Both Norwegian and foreign consumers consider *Electricity*, *Crude Oil and Natural Gas*, as well as commodities produced by the primary industries *Agriculture*, *Forestry* and *Fisheries*, as homogenous, and net imports cover the gap between domestic production and demand.

Producers of manufactured goods and tradable services allocate their output between two segregated markets, the domestic and the foreign. It is costly to change this allocation, as output is a Constant-Elasticity-of-Transformation function of deliveries to the export market and deliveries to the domestic market. Prices of exports are exogenous, determined in the world markets.

Energy and emissions

The model gives a detailed description of production of energy mirroring Norway's special situation as a large producer of energy, including extraction, production and export of oil and gas from the petroleum reserves in the North Sea and the Barents Sea.

For all compounds, emission calculations are linked to each economic activity (inputs, production and consumption) at a detailed level (Strøm, 2007). The model provides emissions to air of 12 different air pollutants. Table 1 provides an overview of the specified air pollutants, and their sources.

Table 1: Air pollutants and important sources in MSG-6

Pollutant	Important sources MSG-6 industry in parenthesis
Kyoto gases	
Carbon Dioxide (CO_2)	Combustion of fossil fuels (Several) Reducing agents (Manufacture of Metals) Gas power generation (Production of Electricity, Oil and Gas Extraction) Flaring (Oil and Gas Extraction)
Methane (CH_4)	Livestock, manure management (Agriculture) Landfills Production and use of fossil fuels and fuel wood (Several)
Nitrous Oxide (N_2O)	Fertilising (Agriculture), fertiliser production (Manufacture of Industrial chemicals) Road traffic (Road Transport)
Perflourocarbons (PFCs)	Aluminium production (Manufacture of Metals)
Sulphur Hexafluoroides (SF_6)	Magnesium production (Manufacture of Metals)
Hydrofluorocarbons (HFCs)	Cooling fluids (Several)
Other pollutants	
Sulphur Dioxide (SO_2)	Combustion (Several) Process emissions (Manufacture of Metals)
Nitrogen Oxides (NO_x)	Combustion (Several)
Carbon Monoxide (CO)	Combustion (Several)
Non-Methane Volatile Organic Compounds (NMVOCs)	Oil and gas-related activities Road traffic Solvents (Oil Refining, Road Transport, Households)
Ammonia (NH_3)	Road traffic (several) Fertilising (Agriculture)
Suspended Particulates ($PM_{2,5}$ and PM_{10})	Road traffic (Households, Agriculture, Road Transport) Fuel wood (Households)

Source: Bruvoll et al (2003)

Energy combustion is the main polluting activity of firms and households. Both stationary and mobile combustion have imperfect substitutes (see Figure A1 and A2), some do not pollute (hydropower electricity, rail and tramway transport), cause emissions abroad (imports), or in other sectors (gas power electricity, transport by road, sea and air). Firms and households contribute to *Methane* emissions through consumption of several material inputs that generates solid waste, which in turn emits from landfills. A major polluter is *Extraction and Transport of Crude Oil and Gas*. The sector is heavy regulated and treated exogenously in the model. Electricity supply is important in the determination of emissions in the model, as it is specified by three different, substitutable sources. First, hydropower is produced domestically with virtually no emissions to air. Investments are large and irreversible, and sharply decreasing returns to scale limit capacity expansion. The production of hydropower is exogenously controlled in accordance with recent practice and intentions expressed by the government. Secondly, electricity may be imported from the Nordic market. Conditions in the Nordic electricity market determine the electricity price, and net imports equal the residual between domestic production and consumption. Thirdly, the model specifies the technology of gas combustion for domestic electricity production.

3. Calibration of MSG-6

The economic model MSG-6 is calibrated to the National Accounts (NA). The most recent version is calibrated to NA for 2004. The empirical benchmarking of parameter values are based on three different sources; *i*) Base year benchmarking to NA, *ii*) estimated parameters as engel- and substitution elasticities in the consumer demand system that is based on consumer survey data, and *iii*) substitution elasticities in the production technology that is estimated on time series from NA. In addition we utilize other relevant parameters from microeconometric analyses.

The calibration of the emission model in the integrated MSG-6 model is based on two sources of energy data; Energy data in NA based on value terms (fixed prices, million NOK) and energy data from the Energy Statistics (ES), based on physical terms. The NA and ES should be based on the same initial data sources and aggregation levels in order to obtain consistency between the energy use and production measured in fixed prices (million NOK) and the emissions measured in physical terms in the emission model. As in many other countries, these initial data sources are not completely coordinated. The MSG-6 model is based on energy data from the NA, while the emission model is based on emission data that is mostly based on the ES. By linking emissions from the Environmental Statistics to observations of production and consumption in fixed prices (million NOK) to the economic model the three different data sources the NA, Energy Statistics and the Environmental Statistics emissions coefficients are calculated and the integrated MSG-6 model including the emission model is established. Figure 1 illustrates the data available data sources necessary to calibrate the model, while figure 2 illustrates how these sources are used in establishing the integrated CGE-model.

Figure 1. Data input to the CGE-model

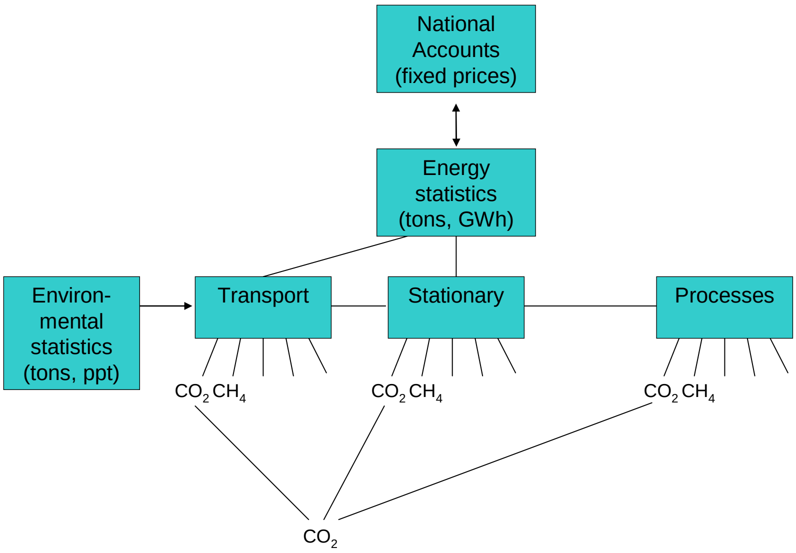
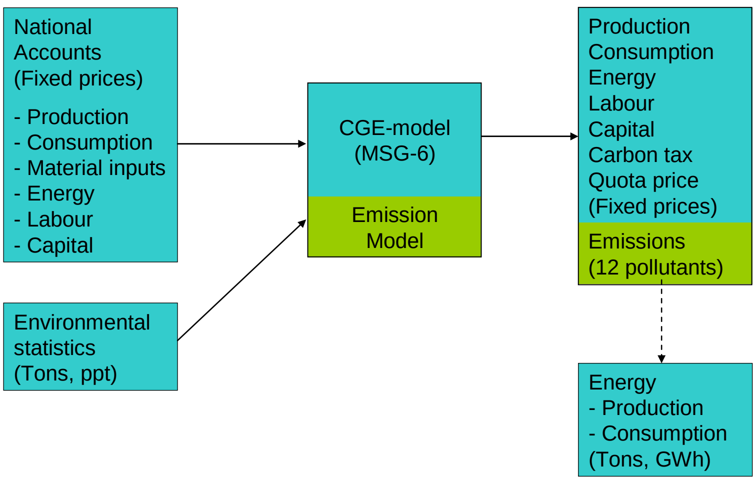
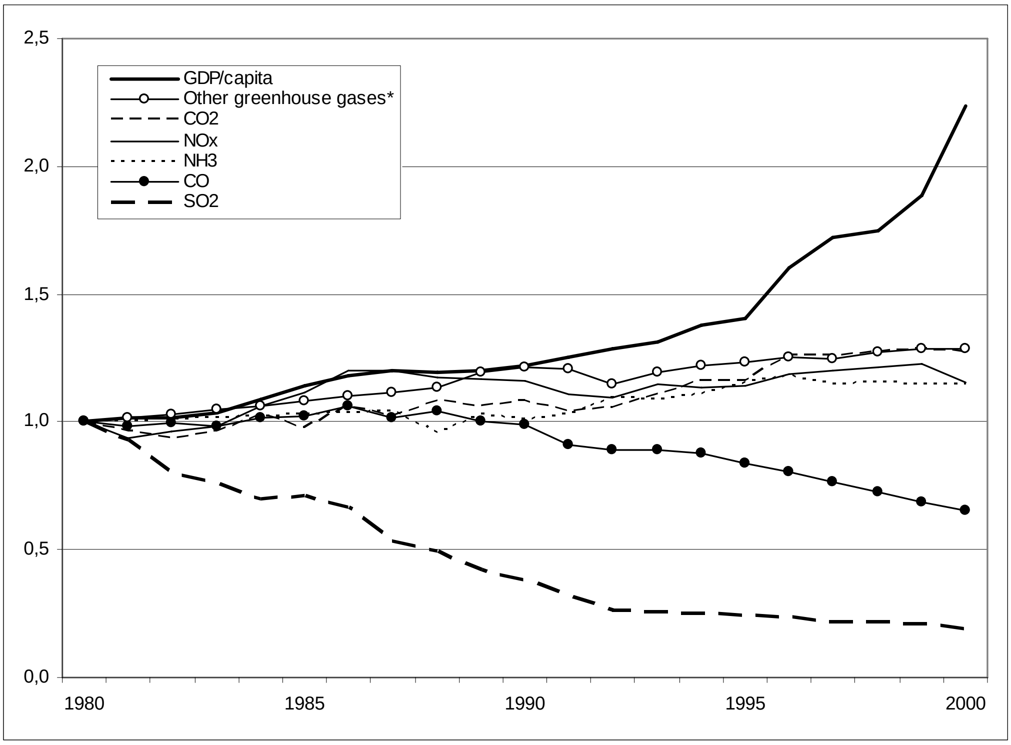


Figure 2. CGE-model



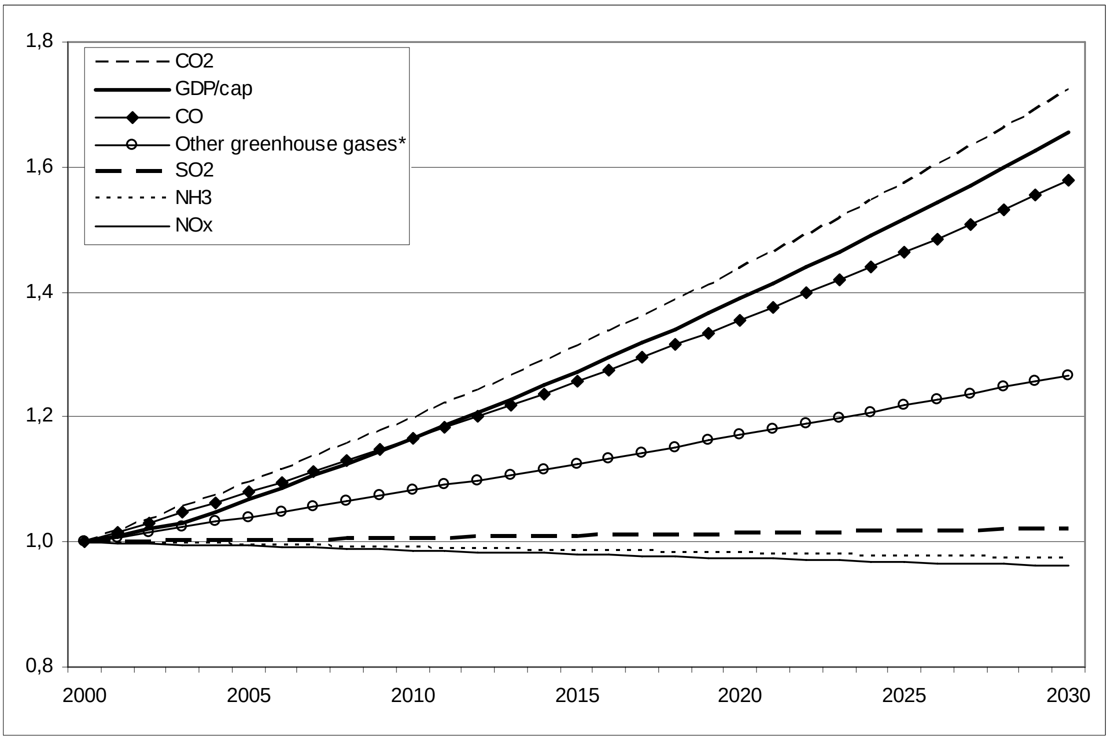
4. Projections and policy analyses

The model is used for projections of long term economic development (year 2030) by the Ministry of Finance. This gives long term development of energy production, consumption and corresponding emissions to air. Such projections are a necessary tool in monitoring whether international environmental agreements as e.g. the Kyoto protocol or the Gothenburg protocol is going to be fulfilled for Norway's respect. The development of emissions based on a consistent economic projection is necessary as an anchor for basing future emission targets for the politicians. Even though Norway is a small contributor to the world's emissions of greenhouse gases, consistent projections must be available in order to compose cost efficient policies, either the targets are domestic reductions, global reductions or a combination. Historic development of emissions (1980 to 2000) is given in figure 3. This confirms a decoupling of the different emissions from the economic development, at least from the 1990-ies. An example of emission projections for Norway (business-as-usual path) is given in figure 4, Bruvoll and Fæhn (2006).



* CH_4 and N_2O.
Source: Statistics Norway.

Figure 3. *GDP per capita and domestic emissions, 1980–2000, 1980 = 1.0*



* CH_4 and N_2O.

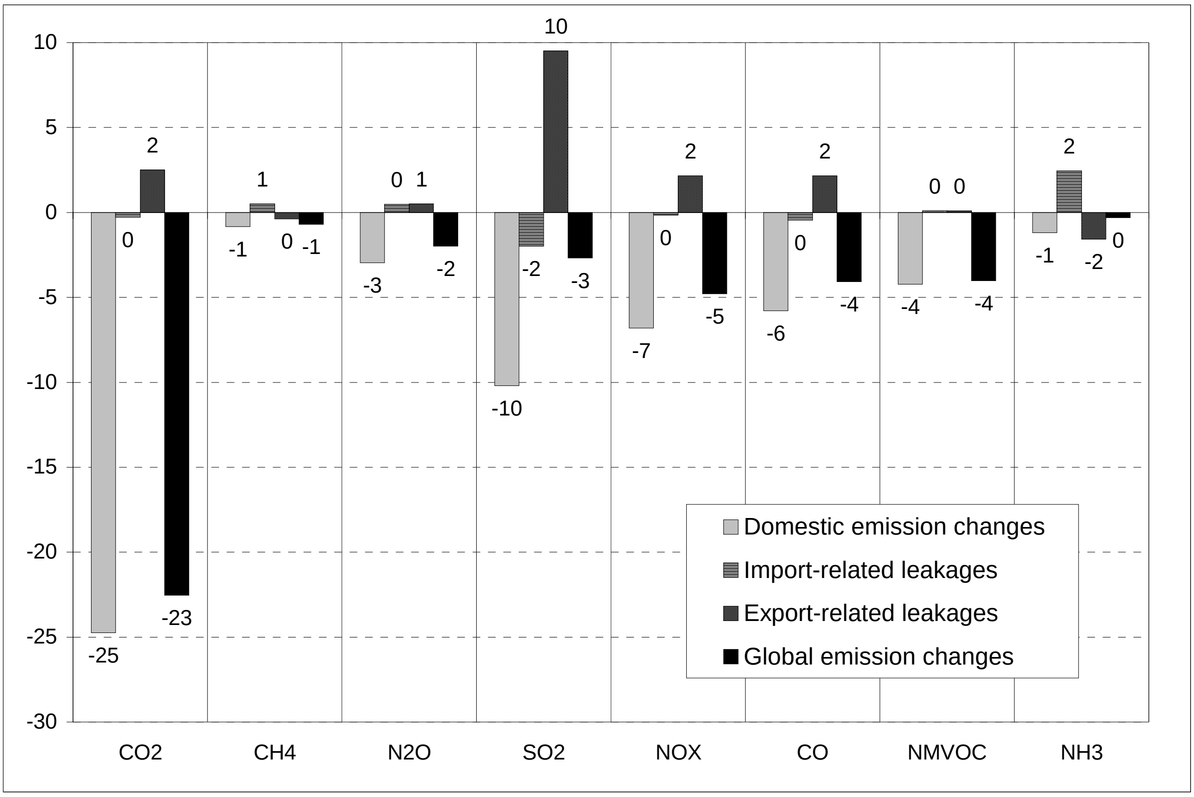
Figure 4. *GDP per capita and domestic emissions, 2000–2030, 2000 = 1.00*

Climate policy instruments as carbon taxes and quota prices are specified in the model. The baseline projections give future emissions of climate gases with business as usual and no new climate policy. By analysing different policy means to reduce future emissions as carbon quota systems, carbon taxes, other environmental taxes and environmental tax reforms, the CGE models calculates economic welfare effects (measured as changes in total discounted consumption) and the effects on emissions of the different climate policies. The MSG-6 model has been used in several analyses that evaluate different kinds of climate policies. Bye (2000a, b) analyse environmental tax reforms as uniform carbon taxation combined with public revenue neutral reductions in labour taxation, and shows that for plausible values of a uniform carbon tax, this would be a welfare enhancing tax reform. The economy will obtain a double dividend, both lower emissions and higher economic welfare.

Bye and Nyborg (2003) analyses the welfare effects of Norway's differentiated carbon tax system compared to a fully auctioned or a grandfathered carbon quota system. The fully auctioned system is welfare superior to the other two systems, but the differentiated tax system is welfare superior to the grandfathered system due to the increase in the distortionary labour tax that is necessary to obtain public revenue neutrality in the grandfathered quota alternative.

Bruvoll, Fæhn and Strøm (2003) investigate whether the decoupling of the growth in several pollutants and the growth in per capita income that is observed since the beginning of the 1990-ties (see figure 3), will extend into the future. Their analysis confirms this hypothesis, especially if the carbon policy is strengthened and made cost efficient. The analysis indicates that pollution leakages abroad are likely to find place, though. The pollution leakages are decomposed and further investigated in Bruvoll and Fæhn (2006) and Fæhn and Bruvoll (2006). They analyse the effects of a cost efficient and strengthened domestic climate policy through a uniform and increasing carbon tax. The uniform carbon tax increases from 13 € in 2000 to 58 € in 2030. The domestic CO2-emissions are reduced by 25 per cent compared to the reference path in 2030, and there is a small domestic welfare loss. They conclude that the environmental benefits of the domestic carbon policies fall (all emissions are higher when leakages are included) when a global rather than national perspective is employed regarding emissions, see figure 3 include emission leakage effects analysed by Bruvoll and Fæhn (2006). The interaction with trade implies that the abatement costs generated by the domestic carbon policy are to some extent shared by the foreigners through lower domestic demand for foreign products (income effect), and higher foreign production of carbon intensive products, both for deliveries to the Norwegian market and to the international market. The latter substitutes with Norwegian exports.

Figure 1: Long-run changes compared to the benchmark in domestic emissions, leakages, and global emissions due to carbon taxes, in percentages.



Bjertnæs, Hagem and Strøm (2007) evaluate the consequences for the Norwegian economy of different climate policy scenarios for the non-ETS[4] sector, i.e. the part of the Norwegian economy that will not be included in the EU emissions trading scheme (ETS). The results show that harmonising the tax level for the non-ETS sector are welfare superior compared to retain the current differentiation of prices of CO2-emissions in the non-ETS sector. It is necessary to point out that when Norway joins the EU-ETS there will at least be two prices on carbon emissions in Norway, the EU-ETS price and the price for the non-ETS sector.

The above mentioned studies are all analyses of indirect regulations as carbon taxes or tradeable quotas, including free issued quotas and auctioned quotas. Many of them implement a given emission target and calculates the optimal carbon tax or quota price for the Norwegian economy to reach this emission target. The calculation of such a cost effective price on carbon emissions for a given emission target highlights the simultaneity between the economic model and the emission model. High quality and consistent data is necessary at all steps in the integrated model generating process in order to obtain reliable results that we can recommend to the policy makers.

The calculations for the Norwegian Low Emission Commission (LEC), Åvitsland (2006), was an extra challenge for the MSG-6 model and the model users, and shed light on some of the weaknesses these kinds of models have in performing analyses of direct regulations and technology shifts. The LEC specifies direct regulations and technology shifts that will reduce domestic carbon emissions by approximately 50 to 70 per cent in 2050, compared to the BAU path. The technology changes were implemented in the model by giving predetermined shifts in exogenous emission coefficients and in factor productivity parameters. Changes in the factor productivity will have cost implications. The LEC mostly imposed direct regulations and only to a minor extent direct costs.

An important feature of the integrated models calibrated to the NA is that the technology, interpreted in a wider concept than the consumption structure, production structure and the input-output structure, is described by the base year NA. This implies that only existing technologies are represented in the model. If new technologies are to be introduced the input-output matrixes and the technology description in the base year must be changed. In particular new products must be introduced. This is not trivial since no data exists in the NA for non-observable technologies and products as for example use of bio-fuels for transport, gas power production with carbon-capture-and-storage (CCS) or without CCS etc. The LEC (Ministry of the Environment, 2006) specified many new technologies that were non-existing in the NA in the base year. To implement such new technologies used as environmental policy means, implies that the model has to be adjusted by the model user more or less ad hoc. The implementation costs of new technologies can then be quite misleading.

5. Future challenges for the integrated top down models and statistics

Technological change is earlier mentioned as an activity that in general will not be independent of the economy’s development and of carbon policies as e.g. taxes, quotas or regulations. The last ten years there has been an increasing literature that analyses technological change and its interplay with environmental policies. Many of these model approaches have been quite simple modelling of technological change. Endogenous technological change based on the Romer (1990) tradition specifies Research and Development (R&D) and development of new technologies as economic activities in line with all the other industries. R&D activities are at present not specified in the NA. To generate a multi sector CGE model with an R&D industry it is necessary to use other primary statistics sources to quantify the R&D industry. The NA has to be corrected for the new R&D industry in order to generate a consistent input-output matrix in the model. Full implementation of the R&D statistics in NA will simplify the generation of models with endogenous technological change mechanisms.

---

[4] EU-ETS is the EU emission trading scheme.

Bye et al (2008) presents a CGE model for the Norwegian economy that models endogenous technological change generated by an R&D industry. The model specifies two R&D industries; one producing new general technologies and the other producing environmental technologies. Heggedal and Jacobsen (2008) uses this CGE model and analyses welfare effects of innovation policies combined with different kinds of carbon emission restrictions.

In the MSG-6 model abatement costs are only represented as the costs of emissions and the welfare loss measured as foregone consumption that the carbon tax or quota generate. Producers and consumers adjust to the carbon tax or quota by imposing abatement activities. Resources to abatement activities are not specified as a separate activity in the NA. In order to model abatement as an industry delivering abatement input to other industries questions as the following must be answered; How to measure abatement activities, are abatement activities produced within the firm or in external firms etc.?

Environmental quality is not included in the objective function and feed-back effects are not included in the interlinked economy-energy-emissions models. Transparent indicators for measuring sustainable development are preferred compared to include more uncertain feed-back effects into the interlinked model. Interlinked models are often criticised of being a “black box” indicating that policy analyses performed on these models are often difficult to interpret. Including feed-back effects will make these models even less transparent.

References

Aasness, J. og B. Holtsmark (1995): Effects of Consumer Demand Patterns of Falling Prices in Telecommunication. *Working Paper 1995:8*, Cicero.

Alfsen, K. H., A. Brendemoen and S. Glomsrød (1992): Benefits of Climate policies: Some tentative calculations, *Discussion Papers 69*, Statistics Norway.

Alfsen, K. H., T. Bye and E. Holmøy (1996): MSG-EE: An applied general equilibrium model for energy and environmental analyses, *Social and Economic Studies no. 96*, Statistics Norway.

Alfsen, K.H. (1997): "Grønne" makromodeller (Green Macroeconomic models), in *Brekke, K. A., Ø. Lone and T. Rødseth (ed.) Økonomi og Økologi; Verktøy for bærekraftig utvikling,* Ad Notam Gyldendal.

Andreassen, L. and G. Bjertnæs (2006): Tallfesting av faktoretterspørsel i MSG6, *Notater 2006/7*, Statistisk sentralbyrå.

Bjertnæs, G.H., C. Hagem and B. Strøm (2007): Beregninger av økonomiske konsekvenser av ulike klimapolitiske scenarioer.(Calculations of the economic consequences of different climate policy scenarios) Appendix 3, *NOU 2007:8*, *The Excise Tax Commission*, Ministry of Finance.

Bruvoll, A. and T. Fæhn (2006): Transboundary effects of environmental policy: Markets and emission leakages, *Ecological Economics* 59/4, 499-510

Bruvoll, A., T. Fæhn and B. Strøm (2003): Quantifying central hypotheses on environmental Kuznets curves for a rich economy: A computable general equilibrium study, *The Scottish Journal of Political Economy* 50 (2), 149-173.

Bye, Brita, Torstein Bye and Lorents Lorentsen (1989): SIMEN – Studies of industry, environment and energy towards 2000, *Discussion Paper 44*, Statistics Norway.

Bye, Brita (2000a): Environmental tax reform and producer foresight: An intertemporal computable general equilibrium analysis, *Journal of Policy Modeling*, Vol. 22, No. 6, 719-752.

Bye, Brita (2000b): Labour market rigidities and environmental tax reforms: Welfare effects of different regimes, in *Harrison, G. W., L. Haagen Pedersen, T. F. Rutherford and S. E. Hougaard Jensen (eds): "Using Dynamic Equilibrium Models for Policy Analysis", 259-294*, North-Holland.

Bye, Brita and Karine Nyborg (2003): Are Differentiated Carbon Taxes Inefficient?

A General Equilibrium Analysis, *Energy Journal* **24** (2), 2003, 1-18.

Bye, Brita, Tom-Reiel Heggedal, Taran Fæhn, Karl Jacobsen and Birger Strøm (2008): A CGE model of induced technological change with two R&D industries: A detailed model description, forthcoming as Report, Statistics Norway.

Fæhn, T. and A. Bruvoll (2006): Richer and cleaner - at others' expense?, *Discussion Papers 477*, Statistics Norway.

Goulder, L. and S.H. Schneider (1999): Induced technological change and the attractiveness of CO2 abatement policies, *Resource and Energy Economics*, 21, 211-253.

Heggedal, Tom-Reiel and Karl Jacobsen (2008): Timing of innovation policies when carbon emissions are restricted: an applied general equilibrium analysis, *Discussion Paper 536*, Statistics Norway.

Heide K.M., E. Holmøy, L. Lerskau og I.F. Solli (2004): Macroeconomic Properties of the Norwegian Applied General Equilibrium Model MSG6. *Reports 2004/18*, Statistisk Sentralbyrå.

Johansen, Leif (1960): *A multi-sectoral study of economic growth*, Amsterdam: North-Holland Publishing Company.

Johansen, Leif (1974): *A multi-sectoral study of economic growth. Second Enlarged Edition*, Amsterdam: North-Holland Publishing Company.

Ministry of the Environment (2006): The Low Emission Commission (In Norwegian: Et klimavennlig Norge), *NOU 2006:18*.

Ministry of Finance (2004): Perspektivmeldingen - utfordringer og valgmuligheter for norsk økonomi. *St.meld. nr. 8*.

Moum, Knut (ed.) (1992): Klima, økonomi og tiltak – KLØKT (Climate, economy and policy), Reports 92/3, Statistics Norway.

Otto, V.M., A. Løschel and J. Reilly (2006): Directed Technical Change and Climate Policy, *FEEM Nota Di Lavoro 81* – 2006.

Popp, D. (2004): ENTICE: endogenous technological change in the DICE model of global warming, *Journal of Environmental Economics and Management* 48, 742-768.

Rosendahl, K. E. (ed.) (1998): Social costs of air pollution and fossil fuel use, *Social and Economic Studies 99*, Statistics Norway.

Strøm, Birger. (2007a): Utslippsregnskap 1990-2004: Etablering av datagrunnlag for likevektsmodeller: Teknisk dokumentasjonsnotat, *Notater 2007/13*, Statistics Norway.

Strømsheim Wold, I. (1998): Modellering av husholdningenes transportkonsum for en analyse av grønne skatter. Muligheter og problemer innenfor rammen av en nyttetremodell. Notater 98/98, Statistics Norway.

Åvitsland, Turid (2006b): Reductions in greenhouse gas emissions in Norway - calculations for the Low Emission Commission, *Reports 2006/44*, Statistics Norway.

Appendix A

Table A.1: Production Activities in MSG-6

MSG-6 Code	Production Activities
11	Agriculture
12	Forestry
13	Fishing
14	Breeding of Fish
21	Fish Products
22	Meat and Dairy Products
16	Grain, Vegetables, Fruit, Oils, etc.
17	Beverages and Tobacco
18	Textiles, wearing Appeal and Footwear
26	Furniture and Fixtures
27	Chemical and Mineral Products, incl. Mining and Quarrying
28	Printing and Publishing
34	Manufacture of Pulp and Paper Articles
37	Manufacture of Industrial Chemicals
41	Gasoline
42A	Diesel Fuel
42B	Heating Fuels, Paraffin, etc.
43	Manufacture of Metals
46	Manufacture of Metal Products, Machinery and Equipment
47	Hired Work and Repairs
48	Building of Ships
49	Manufacture and repair of oil drilling rigs and ships, oil production platforms etc.
55	Construction, excl. of Oil Well Drilling
60	Ocean Transport - Foreign
63	Finance and Insurance
66	Crude Oil
67	Natural Gas
68	Services in Oil and Gas Exploration
69	Pipeline Transport of Oil and Gas
71	Production of Electricity
72	Power Net Renting
73	Sales and Distribution of Electricity
75	Car and Other Land Transportation
76	Air Transport
77	Railroads and Electrical Commuters
78	Ocean Transport - Domestic
79	Post and Tele Communication
81	Wholesale and Retail Trade
83	Dwelling Services
85	Other Private Services
89	Imputed Service Charges from Financial Institutions
	Government Input Activities
	Central Government
92C	Defense Exclusive of Military Submarines and Aircraft
92U	Military Submarines and Aircraft
93S	Central Government Education and Research
94S	Central Government Health-Care and Veterinary Services etc.
95S	Other Central Government Services
	Local Government
93K	Local Government Education and Research
94K	Local Government Health-Care and Veterinary Services etc.
95K	Other Local Government Services

Figure A1. *The preference structure of the household*

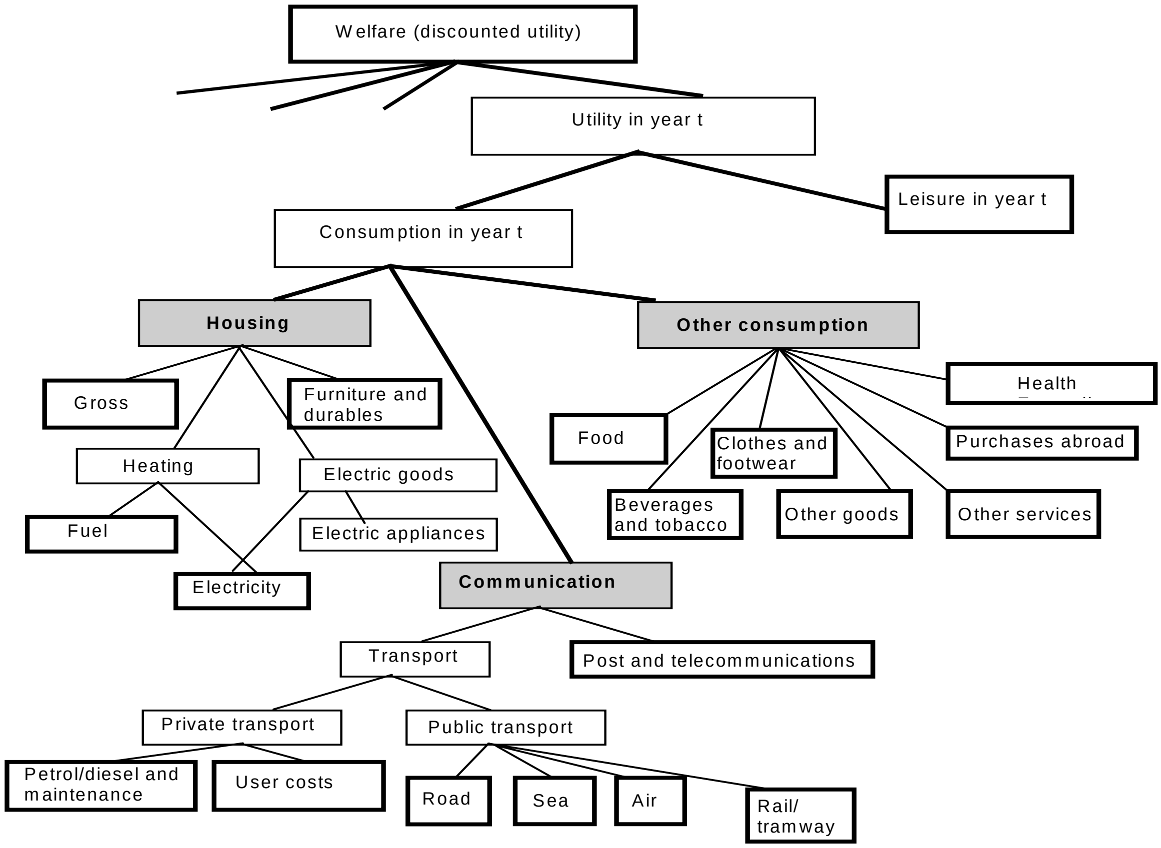
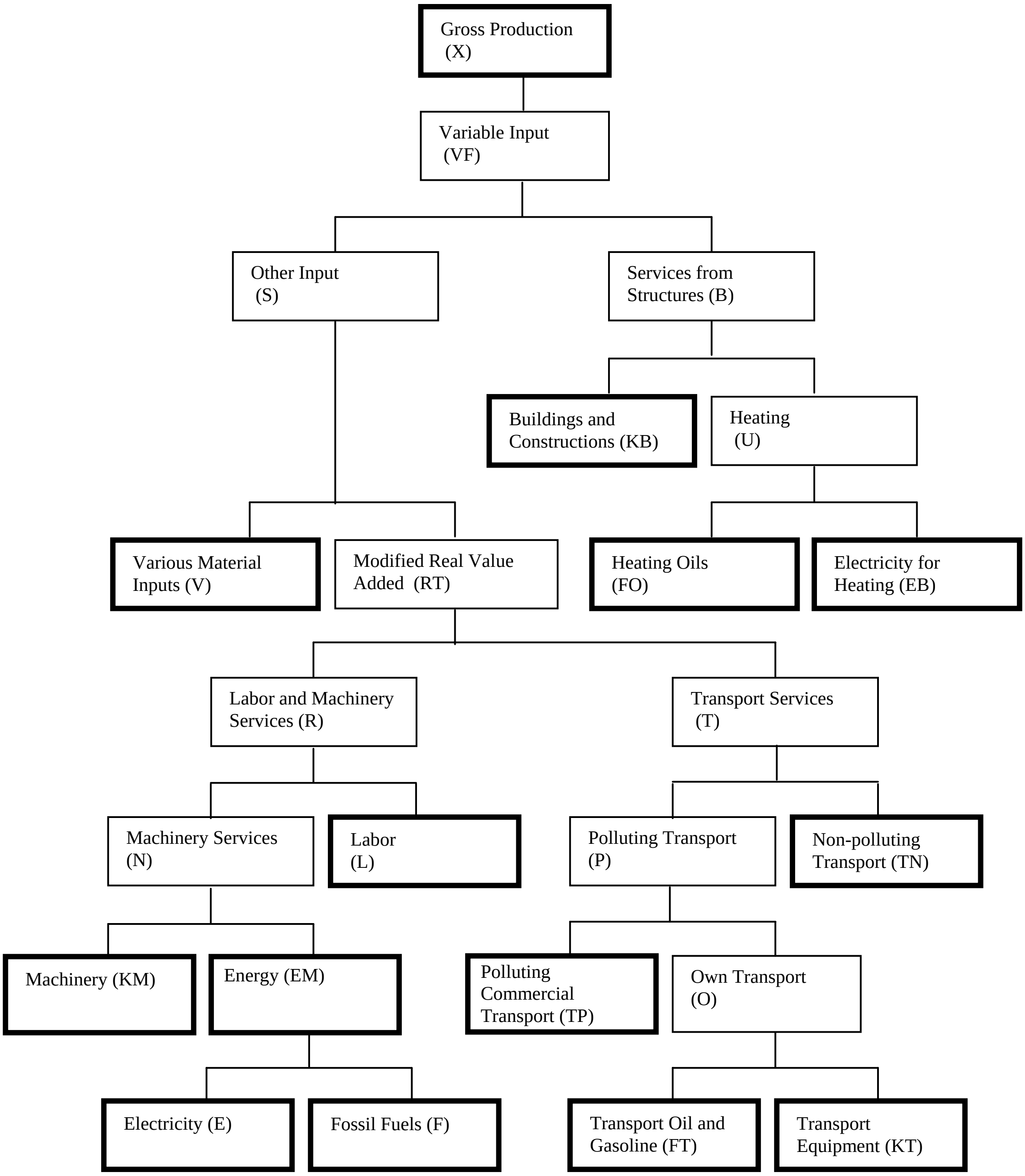


Figure A2. Production technology



Measuring the Impacts of Climate Change

Are Central Statistical Offices Prepared to Track the Impacts of Climate Change?

Conference on Climate Change and Official Statistics

Oslo, Norway

14-16 April 2008

Michael Bordt and Robert Smith

Environment Accounts and Statistics Division

Statistics Canada

Table of contents

1 Introduction – Scope and purpose 3
2 Expected impacts of climate change 3
2.1 Biophysical Impacts 3
2.1.1 Changes in climate patterns 3
2.1.2 Shifting of land use cover and impacts on species and habitat distribution 4
2.2 Social Impacts 4
2.2.1 Health 4
2.2.2 Loss of cultural resources and values (particularly in the North) 5
2.2.3 Changes in population distribution 5
2.3 Economic Impacts 5
2.3.1 Effects on agriculture and forestry 5
2.3.2 Effects on fisheries and aquaculture 5
2.3.3 Changes in energy demand patterns 6
2.3.4 Impact on transportation and access to resources 6
2.3.5 Impact on infrastructure and utilities 6
2.3.6 Changes in prices 6
3 The role statistical infrastructure in measuring climate change impacts 7
3.1 Frameworks 7
3.1.1 Frameworks – Statistics Canada's experience 8
3.2 Knowledge development 9
3.2.1 Knowledge development – Statistics Canada's experience 10
4 Data needs 10
4.1 Biophysical impacts 10
4.2 Social impacts 11
4.2.1 Health 11
4.2.2 Population distribution, income and economic well-being 12
4.3 Economic impacts 13
4.3.1 Impacts on natural capital 14
5 Conclusions 15
References 17

1 Introduction – Scope and purpose

Central statistical agencies and agencies that produce official statistics have been essential to tracking economic and social phenomena for the past 90 years. Over the past 30 years, they have developed some capacity for analysing environmental phenomena and linking them to the social and economic trends. Recently, statistical agencies have been improving their understanding and measurement of the linkages and consolidating these relationships in sets of environmental accounts.

Climate change has the potential to create a wide range of biophysical, social and economic impacts. The paper will highlight (a) the range of expected biophysical, social and economic impacts due to climate change (b) and examine environmental accounts and other statistical and data frameworks to evaluate their ability to track these impacts. Statistics Canada's experience will be used as an example of what can be done in practical terms. The paper will conclude with a discussion of what is missing and suggest priorities for filling perceived gaps.

The paper focuses on direct biophysical, social and economic impacts from a Canadian perspective. It is recognized that other countries are subject to impacts different from Canada and that secondary impacts are also necessary to consider. However, these are not treated exhaustively in this paper.

2 Expected impacts of climate change

Climate change is predicted to affect all Canadians to a greater or lesser extent as a result of its impact on their environment, society and economy. Climate changes are expected to vary regionally. While it is not possible to predict changes with certainty, there is a very high degree of agreement among scientists that changes are already occurring and that further changes will occur. Expected changes in Canada include warmer winters, more frequent summer heat waves, changes in precipitation, changes in wind patterns, and an increased frequency of severe storms. Warming is expected to be most pronounced in arctic regions, causing permafrost to melt and glaciers to retreat more quickly (Field et al. 2007).

Canadians will face challenges in managing the effects of climate change. Regional droughts may result in water shortages. Rising sea levels and heavy precipitation events may lead to greater flood damage. Warmer temperatures will favour more frequent thunderstorms and tornadoes.

This section provides a brief overview of the climate change impacts that are predicted to affect Canada. It is important to keep in mind that these impacts will vary greatly, due to the diversity of climates, landscapes, communities and economies occurring within the country.

2.1 Biophysical Impacts

2.1.1 Changes in climate patterns

Canada has, on average, warmed by more than 1.3 degrees Celsius since 1948 (Natural Resources Canada 2007). All of Canada is projected to continue warming during the next 80 years, although warming will not be uniform across the country. Temperature increases this century are projected to be greatest in the high Arctic and in the central portions of the country.

Changes in national precipitation trends are difficult to track and even more difficult to predict. Some regions, like the high Arctic, are predicted to become significantly wetter (Natural Resources Canada 2007). Other areas are expected to receive lower amounts of summer rainfall. These changes will affect the hydrologic patterns in regions throughout Canada.

Also affecting hydrologic patterns is the possibility of glaciers melting. Glaciers play an important role in the provision of fresh water in some parts of Canada. However, some glaciers in the Rocky Mountains are receding and thinning, resulting in decreases in glacial streamflow during the critical driest months of the year. For example, the total glacial area in the North Saskatchewan River Basin decreased 23% from 1975 to 1998 (Dumuth 2007).

While single storm events cannot be attributed to climate change, scientists predict that climate change will affect storm patterns and result in increased storm activity (Solomon *et al.* 2007). Extreme weather events such as storms, floods, hurricanes and tornadoes can have devastating consequences. Economic losses from extreme events and natural disturbances can be very high, and are difficult to predict. As was the case with the 1998 ice storm in Ontario and Quebec, employment, retail trade, land cover and the viability of specific economic sectors can all be affected by extreme weather events (Statistics Canada 1998).

2.1.2 Shifting of land use cover and impacts on species and habitat distribution

The influence of climate change on Canada's habitats and ecosystems will depend greatly on factors such as species composition, site conditions and local microclimate (Natural Resources Canada 2004). Climate instability may lead to habitat change and species migrations. However, migrations may not always be successful either due to rapid change in weather patterns or to habitat fragmentation.

Rising sea levels due to climate change may also affect land cover by altering the extent and nature of coastal habitat.

2.2 Social Impacts

2.2.1 Health

Climate change has the potential to have a significant impact the health of Canadians. These impacts may be direct, occasioning increases in weather-related conditions such as heat stroke, heat exhaustion and cardio-respiratory diseases (Environment Canada 2007). Other impacts may be less direct, such as changing disease vectors, pollutant levels and risks of natural disasters.

Higher air temperatures may lead to greater levels of ground-level ozone. Observed health effects of human exposure to ozone and particulate matter include respiratory symptoms such as coughing, triggering of asthma attacks and episodes of chronic bronchitis, emphysema, angina and other heart conditions (Statistics Canada, Environment Canada and Health Canada 2007).

Climate change may also increase the incidence and distribution of vector-borne diseases. Warmer conditions could encourage the northern migration of mosquitoes, ticks and fleas that could then increase the incidence of diseases such as West Nile virus, malaria and Lyme disease (Natural Resources Canada 2004).

2.2.2 Loss of cultural resources and values (particularly in the North)

Subsistence hunting and other uses of natural resources are central to the culture of many Aboriginal communities. The subsistence economy may constitute one-half to one-quarter of the total economy of these communities and be worth about $15,000 per household in the Arctic (Berkes and Fast 1996 in Natural Resources Canada 2007), although the full range of values allocated to the use of resources are broad and go beyond economic issues.

2.2.3 Changes in population distribution

Climate change could impact the viability of some economic activities. Such changes could lead to population redistribution.

Although agriculture, forestry, fishing and hunting account for only about 2% of Canada's GDP, many communities depend on the viability of these economic sectors for survival. For instance, more than 1,600 Canadian communities are more than 30% reliant on one or more climate-dependant industries (i.e., agriculture, forestry, fishing and hunting) for their economic well-being (Natural Resources Canada 2007).

2.3 Economic Impacts

2.3.1 Effects on agriculture and forestry

Both agriculture and forestry are very sensitive to climate patterns, including temperature and moisture availability. Climate change is expected to have both a positive and negative impact on agriculture in the short term. Warmer climate patterns may increase the growing season, but may also occasion heat stress as well as water and pest problems (Natural Resources Canada 2004). Specific impacts will vary by crop and by region.

Changes in the frequency and intensity of extreme weather events (such as droughts, extreme heat and storms) are some of the main climate change impacts faced by the agricultural sector.

In a similar way, changes in climate patterns can significantly affect Canada's forest cover. Future climate change is expected to affect species distribution and forest productivity (Natural Resources Canada 2004).

Patterns of disturbance, such as pests and forest fires, are also affected by climate. Changes in these patterns, in fact, threaten to overwhelm more gradual species and land cover changes described above. Disturbances present a particularly important concern for the forestry sector (Natural Resources Canada 2004). The severity of fire seasons is generally expected to worsen and the risk of forest fires to increase across most of the country (Natural Resources Canada 2004).

2.3.2 Effects on fisheries and aquaculture

Shifting climate conditions could lead to changes in water temperature, water levels, number of extreme weather events, ice cover, diseases and shifts in predator-prey dynamics (Natural Resources Canada 2004). All of these impacts could have a significant impact on the extent and distribution of fish populations.

Toxic algal blooms, which may increase due to warmer weather patterns, will also have a negative impact on aquatic life.

2.3.3 Changes in energy demand patterns

Changes in climate patterns will almost certainly have an impact on energy use. For instance, warmer summers could continue to increase peak summer electrical loads due to demands for cooling. However, heating demands may decline with the advent of warmer winters.

2.3.4 Impact on transportation and access to resources

Transportation may be impacted by climate change through shifts in temperature and precipitation, increased numbers of extreme weather events, and changes in water levels (Natural Resources Canada 2004).

Milder winter weather is expected to inflict less damage to the transportation infrastructure and to occasion fewer weather-related accidents. However, the possibility of a greater number of extreme weather events could have a significant impact on traveler safety and on road infrastructure maintenance.

With regard to commercial transport in the south of Canada, Great Lakes shipping and coastal infrastructure are particularly vulnerable to climate change impacts.

Perhaps the most vulnerable transportation infrastructure in Canada is associated with the many winter-only roads that occur in Canada's North. These roads sometimes form the only road transportation link to northern communities.

Several winter roads are of critical importance to resource extraction. For instance, the longest winter road in Canada, 600 km in length, is the main supply road for the Ekati and Diavik diamond mines, the Snap Lake and Jericho mine developments and several other mineral exploration projects (Natural Resources Canada 2007).

2.3.5 Impact on infrastructure and utilities

The three most vulnerable areas of Canada's infrastructure are winter roads (mentioned above), coastal erosion and permafrost degradation (Natural Resources Canada 2007). Many types of infrastructure are currently dependant on permafrost, including buildings and other facilities such as retention ponds for hazardous materials.

Changes in hydrological regimes can also lead to infrastructure impacts. Hydro-electric facilities, for instance, can be affected due to changes in water flow. Water treatment plants may also have to content with increased levels of bacterial, nutrient and other contaminants.

2.3.6 Changes in prices

The cost of resources and services may change, both within Canada and internationally. These changes will be both positive and negative for Canada (Natural Resources Canada 2007). Although a comprehensive review of changes is not within the scope of this paper, climate change could impact the costs of energy. Food prices may increase due to changes in crop viability. Many of the impacts mentioned above may result in more general price increases, though these are difficult to predict.

3 The role of statistical infrastructure in measuring climate change impacts

The section discusses the infrastructure – frameworks and knowledge – required by statistical offices if they are to respond ideally to measuring the impacts of climate change.

3.1 Frameworks

By frameworks, we mean the tools we use to give structure to statistics. These include conceptual frameworks; measurement frameworks, like the System of National Accounts; and standard classifications of, for example, industries and regions. Without these, information is collection and dissemination is *ad hoc*, unstructured and of limited value for decision making.

Over many years, statistical offices have built frameworks that have come to serve them very well in the domains of economic and social statistics. The question now is whether these frameworks are sufficient also for measuring the impacts of climate change and, if not, what more is needed.

Looking first at conceptual frameworks, there are several that figure prominently in official statistics, but perhaps none more so that the framework underlying macroeconomic statistics.[1] This framework has allowed statistical offices to build large and successful systems of macroeconomic accounts that are routinely used in developed nations for economic policy making. Given that climate change and its impacts are also "macro" issues, can this same framework be brought to bear to measure the missing link in climate change statistics, the environment? We think yes.

Our view is that the conceptual framework underlying the national accounts – suitably broadened – could be effectively used in measuring climate change impacts. Over the last two decades a robust literature has developed around "natural capital" as an extension of the traditional concept of capital. Natural capital broadens the traditional concept to cover those elements of the environment that provide goods and services from which humans benefit. Since it is these same elements of the environment (natural resources, land and ecosystems) that we worry about when it comes to climate change, the concept of natural capital provides a firm footing for building statistics on climate change impacts.

Conceptual frameworks are abstract and, as such, cannot be used directly to organize statistics. For that, they must first be turned into measurement frameworks. In the case of macroeconomic statistics, the measurement framework is the well-known *System of National Accounts*. In the case of environment statistics, a similar measurement framework has evolved over the last 15 years. Known as the *System of Environment and Economic Accounts* (United Nations *et al.* 2003), it provides for the organization of

---

[1] Another would be the conceptual framework that underpins demographic statistics.

environmental statistics into structured accounts that are compatible with the concepts of natural capital.

The final framework element required is a set of classifications that can be used to organize raw data into basic statistics that can, in turn, serve as the basis for filling the measurement frameworks needed to measure climate change impacts. For this, many of the traditional classifications used in official statistics are relevant: classifications of industries, products and geography to name some. The traditional classifications alone are not sufficient however. In addition, we require classifications that allow us to look at the economy and society through an environmental "lens." Climate change is an environmental phenomenon, so studying its impacts means first putting economic and social data in an environmental context. This means adding to existing geographic classifications new classifications that divide the national territory not according to political or census boundaries, but into biophysical units like watershed basins and ecological zones.

These are needed because the impacts of climate change will not observe political boundaries but will be differentiated by the biophysical features of the land. The ability to cast social, economic and environmental data according to these biophysical boundaries is essential to measuring impacts. It is worth noting that along with these new classifications must also come the ability to compile and analyse data using various spatial units. In practical terms, this means developing the capacity to use geographic information systems.

3.1.1 Frameworks – Statistics Canada's experience

Statistics Canada has had an environment statistics program since the 1970s. Our initial environmental publications were compendia of socio-economic statistics re-cast in environmental frameworks (Statistics Canada 1979): population by drainage area and agricultural intensity by ecozone. Existing spatial frameworks were assessed for fitness for use and improved in collaboration with the science departments that created the spatial frameworks for their own purposes.

Statistics Canada has contributed to the development of a national geospatial infrastructure framework, which ensures that geospatial data are interoperable between applications and federal departments. This is essential to the rapid response to emerging issues that require the combination of several spatial datasets (Natural Resources Canada, ND).

A program of environmental accounting was started in the early 1990s out of a need to measure the environmental influences of socio-economic activities. The *Canadian System of Environmental and Resource Accounts* today includes:

- Natural resource stocks: conventional oil and gas, offshore oil and gas, oil sands, coal, major commercial minerals, timber and water (under development)
- Land: urban, cropland, forested, grassland, tundra, snow and ice
- Material and energy flow: energy use, water use, greenhouse gas emissions
- Environmental protection expenditure: government and business expenditures

The accounts represent a good start at incorporating the contribution that natural capital makes to Canada's economy. They are largely compatible with the UN *System of Environmental and Economic Accounts*. However, they do not at this stage track all important natural resource and pollutant flows. A comprehensive set of indicators based on these accounts was last published in 2000 (Statistics Canada 2000).

Adherence to standard classifications ensures that Statistics Canada's environmental accounts and statistics are coherent vertically (*i.e.*, aggregates can be derived from details), horizontally (*i.e.*, datasets from different sources can be compared) and temporally (*i.e.*, a dataset from one year is compatible with that from another year). The following classifications are important:

- the North American Industry Classification System
- the Standard Geographic Classification
- the North American Product Classification System
- the Canadian Digital Drainage Area Framework
- the Canadian Ecological Land Classification.

Applying these in the environment accounts assures the interoperability of important datasets. It also enhances the utility of existing socio-economic data.

3.2 Knowledge development

In this section we address the knowledge required in statistical offices if they are to measure the impacts of climate change.

It was noted in Section 2 that climate change will have economic, social and environmental consequences. It seems safe to say that statistical offices routinely have the knowledge required to address the first two but not always the third. And even if a given office does have some environmental knowledge in its workforce, it is almost certain to be a fraction of that which it can bring to bear on economic and social issues. So, at least some building up of this knowledge is probably required in every office; for some, it is a matter of starting from zero.

In acquiring the knowledge to address environmental concerns, statistical offices face several challenges. Most obviously, there is the challenge of recruiting staff with the appropriate professional training and experience. Since statistical offices are not always widely known for their environmental work, potential employees might not think of them when looking for a job or might not be willing to join a statistical office if they perceive it to be on the margins of their profession.

A second challenge is development for environmental professionals. While high-quality training opportunities are routinely available for economic and social statisticians, this is less the case for environmental statisticians. The latter are more likely to have to make do training on the job.

A third challenge is subject-matter thinning. Environment statistics cover a large and complex range of issues that must be followed by a relatively small number of statisticians. This can mean that 1) that some issues go untreated; 2) that particular individuals must cover many issues superficially rather than a few issues in depth; and 3) that progress in expanding statistical coverage is slow.

The final challenge with respect to knowledge is credibility with science-based departments. Because statistical offices are relative newcomers to environmental issues and because they mainly do not have large teams of professionals dedicated to them, there can be a perception by core environmental departments that statistical offices lack the qualifications necessary to do good work in this area.

3.2.1 Knowledge development – Statistics Canada's experience

Statistics Canada's environment statistics program has developed its knowledge base by (a) hiring generalists with some science or engineering background and (b) establishing alliances with working groups in other departments with access to specialized scientific knowledge.

One example is the Canadian Environmental Sustainability Indicators project (Statistics Canada, Environment Canada and Health Canada 2007). To assess the quality of water and air monitoring data, we found statisticians with engineering, hydrology and water quality backgrounds. The individuals had extensive experience in the scientific fields but were already working as statisticians. The project also made extensive use of interdepartmental working groups in which the statistical principles were appropriately considered along with the scientific principles.

Environmental accounting requires a combination of knowledge areas:

- science and engineering to treat the physical, process and chemical aspects;
- national accounting treat the macro-economic principles (e.g., which value to use as a denominator to calculate greenhouse gas intensities),
- statistics to apply appropriate methods to analyse trends and significance, and
- survey knowledge to develop and conduct new surveys.

The ability to properly incorporate geography into the analysis requires not only the spatial frameworks but also specialized skills to translate information between environmental and other geographic frameworks using GIS software.

4 Data needs

In this section we consider the data needed to address each of the main categories of climate change impact. As above, Statistics Canada's experience is used in illustration.

4.1 Biophysical impacts

Shifts and changes to the state of biophysical elements such as weather and seasons, land cover, natural resources and ecosystems undoubtedly have parallel socio-economic impacts. For example, declining fish stocks, occurrence of severe droughts, extensive forest fires, would have corresponding impacts on specific resource industries and the related resource-dependent communities. Unlike the data requirements for socio-economic analysis, however, any meaningful analysis of the shifts in these biophysical elements and how much of these changes could be attributed to climate change requires data that are collected primarily from scientific activities (scientific surveys, laboratory testing, remote sensing, etc.).

In Canada, the majority of these data collection activities fall outside the mandate or realm of activities of the central statistical agency. Instead, they are carried out by other federal policy departments, scientific research institutions, and provincial/local governments that are mandated to report on the status/state of these biophysical elements.

For instance, Environment Canada collects most of the data on climate and weather. Natural Resources Canada and provincial governments collect some data on Canada's forests and on other types of land cover.

A considerable portion of these data are not collected for statistical purposes, but rather, for scientific reporting or for specific case studies and research. It is, therefore, not surprising that data fragmentation or the presence of 'silos' is quite prevalent. The overall completeness and data quality also vary quite widely among the different data sources. These conclusions became quite evident in the evaluation of the ability of the statistical infrastructure to track biophysical impacts of climate change.

Is there a role for central statistical agency? Statistics Canada believes that a statistical agency can play a lead role in the development of a conceptual framework for tracking and measuring these biophysical elements. The framework provides a coherent basis with which to integrate various pieces of the 'biophysical puzzle.'

At Statistics Canada, the *Canadian System of Environment and Resource Accounts* provides the starting point for such a framework. One of the strengths of the system is its ability to bring together scientific data collected by various organizations and put them in order to produce coherent indicators. The accounts operate at the national and broad sub-national level, however, which could be construed as one their weaknesses, since most climate change impacts will be felt locally.

4.2 Social impacts

The anticipated direct social impacts of climate change are on health, cultural resources and population distribution. Information on health (morbidity and mortality) needs to be sufficiently detailed by cause and location to distinguish causes that can be linked to climate change. Similarly, to track the impact on cultural resources, such as subsistence or ceremonial fisheries, surveys need to be in place to collect sufficient detail. To track population distribution, detailed information is required on the location of residence and workplace.

4.2.1 Health

Causes and rates of deaths, morbidity and social and mental stress could result from general increases in temperature and the type, severity and frequency of weather events. For example, increases in ground level ozone as temperatures rise may lead to respiratory problems in people in the affected areas.

Statistics Canada's *Canadian Community Health Survey* collects a variety of self reported information on incidences of illnesses and diseases. Household spending data, if detailed enough, could provide information on spending to adapt to changing environmental conditions; for example, on the purchase of air filters. Information on other adaptive behaviours could be derived through modifications to household environmental behaviour surveys, such as Statistics Canada's *Households and the Environment Survey*.

Longer growing seasons will lengthen the period in which plant pollens are in the air and this will lengthen the exposure period for people suffering from allergies to these pollens. Statistics Canada currently publishes detailed geographic data on self reported allergies and asthma rates collected through the *Canadian Community Health Survey*. These data will serve in monitoring changing impacts of pollen levels to some degree.

Increases in incidences of diseases carried by insects and pests could be impacted by warming temperatures. In the absence of extreme cold weather to kill off insects like ticks and mosquitoes, the incidence of the diseases they transmit could increase. It should be possible to track the increasing incidence of vector-borne diseases using morbidity data sets, though it will be difficult to link incidence rates back to environmental factors.

Climate change could also lead to heat-related health impacts such as heat stroke and sunburn. Increases in these conditions where hospitalization is required should be possible to track. In most cases however these conditions are not treated by physicians and therefore will go unreported.

Changes in climate could also increase the numbers of injuries and deaths related to severe storms and flooding. Morbidity and mortality data sets provide some information in regard to injuries, especially where these lead to death. However, details that would allow linkages to climate change related causes will be limited.

Climate change could lead to changes in mental health, stress, depression, satisfaction and happiness levels related to changes in economic and other conditions resulting from climate changes. In Canada, such data are collected through the *Canadian Community Health Survey* and the *Aboriginal Peoples Survey*.

4.2.2 Population distribution, income and economic well-being

Changes in economic conditions brought on by the availability of water resources, changing temperatures of air and water and extreme weather events will have an impact on how some sectors of the population earn a living. This may stimulate population movements resulting in population increases in some parts of Canada and decreases elsewhere.

Parts of the country that currently depend heavily on biomass based resources for employment may suffer economic downturns and depopulation if those resources are negatively affected by the impacts of climate change. For example, water shortages in agricultural areas may change farming practices that reduce the income potential per hectare of farmed land. This would force some farmers out of business and others to consolidate existing properties. Areas economically dependent on forestry may suffer depopulation as forests are damaged by pests that able to survive milder winters, such as the mountain pine beetle in the interior of British Columbia. Water shortages may also have an impact on forest resources and new insect pests, fungi and diseases may arise to harm agricultural production.

In most countries, including Canada, population census provides a detailed statistical picture of population characteristics and population distribution every five or ten years. Analysis of Census results in conjunction with other scientific monitoring data and economic data can provide a detailed picture of emerging patterns. These data will serve policy makers in designing adaptive strategies. Labour force surveys can also provide useful data. Though not as detailed as census data, labour force data are available frequently and so are useful for current monitoring.

Information on changes in agricultural practices and changing farm characteristics will be important. In Canada, these come from the *Census of Agriculture* every five years. Water consumption in agriculture may become an issue if rainfall patterns are significantly altered from the present. Depletion of groundwater aquifers and melting of mountain glaciers that provide summertime stream flow are also concerns. These issues have prompted the creation in Canada of an *Agricultural Water Use Survey* to ask farmers directly about their water use.

Increased temperatures and more carbon dioxide in the atmosphere may increase agricultural and forestry production in areas of currently marginal production. This may lead to additional settlement in these locations. Population census data will again be helpful in assessing if this is happening.

Changes in water temperatures and ocean currents may have impacts on fish and other aquatic species. If fish populations decrease, there will be a follow through effect on those depending on fishing for their income. Impacts on incomes and population distributions could be assessed using population census and labour force data.

Climate change may increase movement of people seeking security and a better standard of living outside their home countries. In Canada, the *Longitudinal Survey of Immigrants* could provide some information on such arrivals. While it does not ask the reason for emigration, some countries will be more affected by climate change than others, so persons arriving from these locations might be considered, at least in part, as climate change refugees.

4.3 Economic impacts

The economic impacts of climate change will be, to a large extent, functions of the biophysical and sociological impacts outlined above. The economy is a subset of society which is itself situated within the physical world, so economic impacts from climate change are inevitable. It is worth noting that these impacts may affect the economy in both positive and negative ways, with the overall impact being difficult to determine *a priori*.

The economic impacts of climate change can be grouped three main headings; namely impacts on natural capital, produced capital and labour. Changes in the availability of these types of capital, and the productivity with which they can be exploited may influence the structure and output of the economy. The discussion below focuses just on data needs associated with the impacts on natural capital, as these are likely to be the weakest link in statistical systems today.

4.3.1 Impacts on natural capital

Natural capital provides resources to the economy, space in which the economy operates, navigation and transportation routes, and ecosystem services that are vital to economic functions. Natural capital has been divided below into the subheadings of water, land, biological resources and ecosystem services. The capacity of statistical offices to measure the impacts on these types of capital is briefly discussed.

Water

Water is an essential input into many production processes. It can be used as an intermediate input, as a carrier for heat energy, to generate electricity, and as a route for the transport of passengers and economic goods and services. Statistical agencies are well placed to measure the use of water by businesses and households, which by extension can serve as a measure of the impact of climate change should the availability of this resource change in quantity or location.

Statistics Canada conducts an *Industrial Water Survey* to measure the role of water in industrial production. It also conducts surveys of electric power generation that include hydro-electric plants. In addition, Statistics Canada is working on geographically-based water availability accounts that will provide a measure of changes in water availability as time passes. Various surveys also measure the role of water as a conveyance for goods and services, including surveys of domestic and international shipping and a separate financial survey of water carriers. Changes in water availability can influence other aspects of natural capital including land, biological resources, and ecosystem services.

Land

Land provides the space within which economic activities are carried out. The impact of changes in the quality and availability of land as an economic resource is another area where statistical offices are well placed for measurement. Agricultural production is a significant economic activity that is measured by statistical offices. Changes in land availability for agricultural production will show up as an economic impact via changes in agricultural production (similar to changes in water availability above). Statistical offices are well placed to measure this economic impact. Statistics Canada, for its part, conducts a *Census of Agriculture* every five years, and also produces quarterly and annual estimates of livestock production and farm income and expenses.

Land itself has value from an economic perspective. It contributes to national net worth as land around buildings and structures and as agricultural land. Changes in the value of land will be reflected as changes in national net worth. This is another area where statistical offices are well placed to measure the potential impacts of climate change, particularly if they produce environmental accounts.

Non-renewable resources

It is not expected that sub-soil resources (other than groundwater) will be impacted by climate change. However, the ability of the economy to exploit them may change due to impacts on the infrastructure required for their exploitation (this is discussed further under produced capital below). The value of sub-soil assets is calculated in Statistics

Canada’ environmental accounts taking into account their economic viability. To the extent that climate change alters this viability, the impact should be captured through the asset valuation, though it would prove challenging to attribute the changes directly to climate change.

Biological resources

Forests, fisheries, and other biological resources yield economic benefits once harvested. Since these are long-standing economic activities, statistical offices are generally well placed to measure changes in the economic output of the industries that depend on these resources. From an analytical perspective, statistical offices are also well placed to measure the downstream economic impacts of changes in the production of goods based on biological resources.

Timber assets are part of Statistics Canada’s environmental accounts. Changes in the economic value of these assets will be reflected in these accounts, though again it will be difficult to attribute changes in value directly to climate change.

5 Conclusions

Basic social and economic statistics generally collected by statistical agencies should go a long way toward understanding the impacts of climate change in the future. Population, agriculture, economic, health and social data all can be used to tell part of the story and to suggest areas where more data and analysis are required.

Statistical agencies with an environment program already have some of the expertise, or access to it through partnerships with environmental and resource policy departments, to assist with the interpretation of trends resulting from climate change.

It is Statistics Canada’s view that environmental accounts hold the most promise as the analytical framework for assessing climate change impacts. These accounts ensure the coherence of the data, both across different categories of environmental data and also with economic and social data. When we engage in new research, we always therefore ask, “Where will this fit in the environment accounts?”

Given this view, we offer a prioritized checklist for statistical agencies to assess their readiness to track the impacts of climate change:

- Is there an environment statistics program? Does this program have strong linkages in terms of sharing data and knowledge with environment, health, agriculture and natural resource departments? Is there analysis of the environmental factors in social and economic trends?
- Does the environment statistics program adhere to standard classifications for industry, goods and geography? Is there a spatial analysis capacity as part of the environment statistics program and are social and economic data spatially-referenced?
- Does the environment statistics program conduct its own surveys? Does it monitor other health, social and economic surveys for opportunities to add questions on environmental issues?

- Does the environment statistics program have a set of environment accounts linking social and economic activities with environmental pressures (emissions, effluents, protection expenditures, production of environmental goods and services, etc.)? Do the accounts include detailed information on land, forests and water?
- Are official social and economic statistics already being used to assess environmental impacts? Is there an ongoing working relationship between economic and social units in the statistical office environmental, health, agriculture and natural resource statistics units?

Perhaps this checklist could be used as a starting point for international discussion on the statistical agencies' contribution to the understanding of the impacts of climate change. Success in this endeavour will ultimately require the determination of individual statistical agencies and their clients to encourage a role that goes much beyond that of statistical agencies in the past.

References

Dumuth, Michael. Natural Resources Canada. Personal communication June 19, 2007.

Field, C.B. et al., 2007, "North America," *Climate Change 2007: Impacts Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry et al. [eds.], Cambridge University Press, Cambridge, www.ipcc.ch/ (accessed January 11, 2007).

Natural Resources Canada. 2004. *Climate Change Impacts and Adaptation: A Canadian Perspective*. Ottawa, Ontario.

Natural Resources Canada. 2007. *From Impacts to Adaptation: Canada in a Changing Climate 2007*. Ottawa, Ontario.

Natural Resources Canada. ND. Canada's Geospatial Data Infrastructure (www.geoconnections.org).

Solomon, S. et al., 2007, "Technical Summary", *Climate Change 2007:The Physical Science Basis, Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, S. Solomon et al. [eds.], Cambridge University Press, Cambridge, United Kingdom and New York, www.ipcc.ch/ (accessed January 11, 2007).

Statistics Canada, Environment Canada and Health Canada. 2007. *Canadian Environmental Sustainability Indicators,* Statistics Canada Catalogue no. 16-251, Ottawa.

Statistics Canada. 1979. *Human Activity and the Environment,* Ottawa.

Statistics Canada. 1994. *Human Activity and the Environment,* Ottawa.

Statistics Canada. 1997. *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts*. Cat. no. 16-505-GIE.

Statistics Canada. 1998. *The St. Lawrence River Valley 1998 Ice Storm: Maps and Facts*. Cat. no. 16F0021XIB.

Statistics Canada. 1999. *The Preparedness of Canadian Business for the Year 2000 Computer Problem*. Cat. no. 61F0057MIE.

Statistics Canada. 2000. *Econnections: Linking the Environment and the Economy-Indicators and Detailed Statistics*. Cat. no 16-200-XKE.

United Nations, European Commission, International Monetary Fund, Organization for Economic Co-operation and Development, World Bank. 2003. *System of Economic and Environmental Accounts*. New York.

UNITED NATIONS STATISTICS DIVISION

CONFERENCE ON CLIMATE CHANGE AND OFFICIAL STATISTICS

OSLO, APRIL 2008

Paper for session 3

CLIMATE CHANGE AND WATER: HOW WATER ACCOUNTS CAN HELP OUR UNDERSTANDING

Centre of Environment and Energy Statistics
Australian Bureau of Statistics

Summary: Climate change imposes potentially significant changes on meteorological and hydrological systems. To understand the impacts of climate change, information about changes to these physical systems needs to be linked with information about human/economic activities and the broader environment. This paper explores possible ways that regular, comprehensive water accounts can inform our understanding of the implications of and the responses to changing water availability due to climate change. In particular, it describes some possible changes to water use by industries and sectors, as well as efficiency responses to expected increased scarcity and value of water resources. The paper incorporates results from a series of Water Accounts produced by the Australian Bureau of Statistics.

David Bain
Centre of Environment and Energy Statistics
Australian Bureau of Statistics
Telephone: 61 2 62526378
Email: david.bain@abs.gov.au

Introduction

Michael Coughlan and Rob Vertessy from the Australian Government Bureau of Meteorology referred to the critical role of measurement and data to assess impacts of climate change at the recent Australian Bureau of Agricultural and Resource Economics (ABARE) Outlook Conference in Canberra.[1] They noted:

'If you don't measure it you won't understand it.
If you don't understand it you can't model it.
If you can't model it you can't predict it.
If you can't predict it, your ability to manage it will be constrained largely to the application of reactive measures.'

These observations are especially relevant to water and water accounting in Australia, where any changes in the abundance, distribution and availability of water across the continent as a consequence of climate change will pose significant challenges.

The *Integrated Environmental and Economic Accounting for Water Resources* handbook (SEEAW) provides a framework for organising hydrological and economic information in a consistent framework ideal for addressing cross-sectoral issues such as integrated water resource management. SEEAW was developed in support of the *System of Integrated Environmental and Economic Accounting 2003* (SEEA), with special focus on water. Both SEEA and SEEAW are satellite accounts of the *System of National Accounts 1993* (SNA). As such, both SEEA and SEEAW have a similar structure to the SNA and share many common definitions and classifications. SEEAW describes a set of standard tables focusing on hydrological and economic information as well as supplementary tables covering information on social aspects, which permits analysis of the interaction between water and the economy.

The Australian Bureau of Statistics (ABS) has produced water accounts in respect of 1994-95 to 1996-97, 2000-01 and 2004-05. The ABS water accounts were produced in parallel with the development of SEEAW and successive editions reflect the evolution of thought on the role and purpose of accounting for water. The latest, *Water Account Australia 2004-05,* in combination with *An Experimental Monetary Water Account for Australia, 2004-05*, closely follow SEEAW's recommendations and use the SEEAW framework as much as possible within the constraints of existing data. The observations that follow are drawn mainly from these accounts.

There are qualifications on using water accounts to explain climate change. Climate change is one of several factors thought to affect variability of water in Australia and effects of climate change are difficult to differentiate from other influences on Australia's weather. For example, Australia's highly variable annual rainfall is dominated by the El Nino-Southern Oscillation pattern, a discrete, cyclical weather event. Australia was particularly affected by an El Nino induced drought in 2004-05, so comparisons between this and earlier years will include effects of both cyclical weather variability and longer term climate change.

Australia's water accounts are relatively new and have only been compiled in respect of a short time period. Indeed, Australia's official weather/climate records cover a relatively

[1] Coughlan, M., and Vertessy, R., Australian Government Bureau of Meteorology, 2008

short period of history so that differentiation between variable weather cycles and climate change is difficult to discern from official records.

Industry, sectoral and regional information

Water accounts make an important contribution to our understanding of impacts of climate change through their ability to facilitate comparisons of the effects of changing water use patterns across time, across industries, across sectors and across regions.

Table 1, below, is a hybrid account showing details for 2000–01 and 2004–05 for chain volume measures (CVM) of Australia's industry gross value added, water consumption and the ratio of industry gross value to industry water consumption. As expected, the relationship between water consumption and value added by industry varies markedly. For example, agriculture generated on average around $2 million in gross value added for every GL of water consumed in 2004-05—the lowest of any industry. Mining generated an average $155 million and manufacturing an average $169 million for each GL of water consumed in the same period. The average gross value added per GL of water consumed across all industries in 2004–05 was $56 million.

Table 1 also indicates changes in overall water consumption by industries over a short time and changes in their apparent efficiency of water use, indicated by changes in value added per GL of water used from 2000-01 to 2004-05. Although agriculture continued to be the lowest water value adding industry, it did increase its average value added per GL used by a third from 2000-01 to 2004-05. On the other hand, the mining industry value added per GL of water consumed decreased by just over 20% in the period while other selected industries value added per GL of water consumed remained largely unchanged. Across all industries, value added per GL of water consumed increased by 34%; however, as industrial use is dominated by agriculture, any changes in agricultural use are echoed in total industry use.

Table 1. Industry gross value added (chain volume measures) and water consumption for water using industries, 2000-01 and 2004-05

Industry	Industry gross value added $m		Water consumption GL		Industry GVA per GL of water consumed $m	
	2000-01	2004-05	2000-01	2004-05	2000-01	2004-05
Agriculture	23 206	24 344	14 989	12 191	1.5	2.0
Mining	63 691	64 223	321	413	198.4	155.5
Manufacturing	94 474	99 688	549	589	172.1	169.2
Electricity and gas	13 870	14 444	255	271	54.4	53.3
Water supply, sewerage and drainage services	7 724	7 407	2 165	2 083	3.6	3.6
Other industries	617 593	729 585	1 146	1 110	538.9	657.3
Total	**820 558**	**939 692**	**19 425**	**16 657**	**42.2**	**56.4**

Reference year for chain volume measures is 2006-06
Sources: Water Account Australia 2004-05 (ABS cat. no. 4610.0)
Australian System of National Accounts 2006-07 (ABS cat. no 5204.0)

The relationship between water consumption and industry gross value added is dependent upon the nature of production processes taking place within each industry and this cannot readily be represented in a simple table format. Nevertheless, it is worth noting the importance of input-output modelling and its potential to present cumulative consumption of water. For example, businesses manufacturing food, beverage and tobacco products generated an average $89 million in industry gross value added (CVM) per GL of water consumed in 2004-05. However, this excludes the embodied water content of the various inputs to these manufacturing processes and therefore does not show, for example, the cumulative water consumption associated with the manufacture of these products.

Agriculture

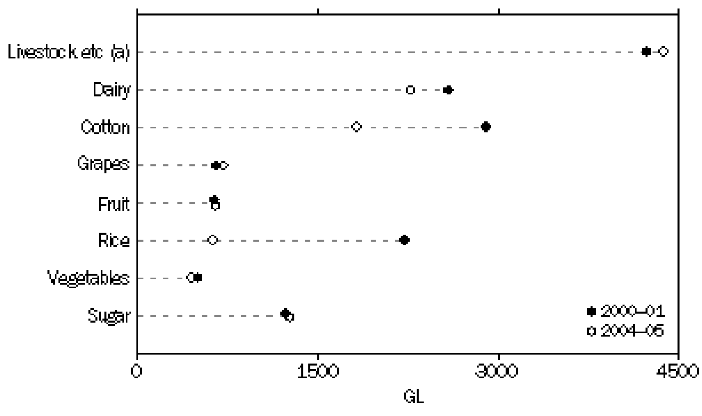
The Australian agriculture industry is considered to be vulnerable to the impacts of climate change, including increases in temperature and atmospheric carbon dioxide, decreases in rainfall over much of temperate Australia, and increased frequency of extreme weather events such as droughts, fires and flooding. Impacts are likely to be complex, both physically and socio-economically, and will vary greatly by production activity and region.[2]

All industries require water to a greater or lesser degree but for agriculture, the availability of water is a key determinant of the output and value added of the industry. The agriculture industry is the single largest consumer of water in Australia, accounting for nearly two-thirds of Australia's total water (including household) consumption.

- Agriculture consumed 14,989 GL in 2000-01, 77% of total industrial (excluding households) water used, while contributing 2.8% to total value added.
- Water consumption by agriculture fell 19% to 12,191 GL in 2004-05, but it still consumed 73% of total industrial water used for 2.6% of total value added.

Water accounts provide a wide range of information about both water uses by agriculture and changing patterns of production. Water usage within the agriculture industry varies widely and is sensitive to both the availability and cost of water. Chart 1 illustrates changes in consumption of water within agriculture between 2000-01 and 2004-05.

Chart 1. Agriculture water consumption, by activity



(a) Includes livestock, pasture, grains and other agriculture (excluding dairy farming).
Source: Water Account Australia, 2004-05 (ABS cat. no. 4610.0).

[2] Australian Government, Department of Climate Change, *Climate Change Impacts and Adaptation*

Some crops such as rice, cotton and grapes are highly dependent on irrigation. For other crops such as grazing pasture and sugar cane, irrigation water supplements natural rainfall or provides moisture at critical periods of plant growth. The area to be irrigated and the volume of water applied depend on the crop type and location. Chart 1 illustrates the sensitivity of certain agricultural production activities to the availability of water. The most significant change in water consumption was for cotton and rice production, both water intensive crops. Water consumption for rice fell from 2,222 GL to 631 GL (-72%) between 2000-01 and 2004-05, while consumption for cotton fell from 2,896 GL to 1,822 GL, (-37%). These decreases were principally due to drought-induced reductions to water allocations and subsequent reductions in irrigated areas for these crops.

Water accounts can help inform decisions about the cost-effectiveness of irrigating different crops. Nevertheless, estimating the value of irrigated agricultural production is difficult because water used by crops comes from a variety of sources. In particular, rainwater is usually a component of the water used by irrigated crops, and the timing and location of rainfall affects the amount of irrigation water required. In addition, water is not the only input into irrigated agricultural production; land, fertiliser, labour, machinery and other inputs are also used. To separate the contribution of each of these factors to total production is extremely difficult, even with ideal data. Therefore, estimates of the gross value of irrigated agricultural production presented in Table 2 attribute all of the gross value of production from irrigated land to irrigated agricultural production.

The estimates of gross value of irrigated agricultural production in Table 2 are not directly comparable with the estimates of industry gross value added presented in Table 1 because gross value of irrigated agricultural production is a measure of output, rather than value added. As such, gross value of irrigated agricultural production should not be used as a proxy for determining the highest value water users—some form of value added measure is instead appropriate for this purpose. At present, the ABS does not produce any value added measure in respect of irrigated agricultural production.

Table 2. Gross value of irrigated agriculture production and water consumption, 2000-01 and 2004-05

Activity	Gross value of irrigated production $m		Water consumption GL		Gross value per GL of water consumed $m	
	2000-01	2004-05	2000-01	2004-05	2000-01	2004-05
Dairy farming	1 499	1 632	2 593	2 276	0.6	0.7
Vegetables	1 817	1 761	507	455	3.6	3.9
Sugar	284	477	1 235	1 269	0.2	0.4
Fruit	1 590	1 777	645	648	2.5	2.7
Grapes	1 355	1 314	655	717	2.1	1.8
Cotton	1 222	908	2 896	1 822	0.4	0.5
Rice	350	102	2 223	631	0.2	0.2
Livestock, pasture, grains & other	1 500	1 104	4 235	4 374	0.4	0.3
Total	**9 618**	**9 076**	**14 989**	**12 191**	**0.6**	**0.7**

Source: An Experimental Monetary Water Account for Australia, 2004-05 (ABS cat. no. 4610.0.55.005)

Mining and Manufacturing

The mining and manufacturing industries use water for cleaning, cooling, product movement, dust suppression and as a raw material. These industries use water from both distributed supply and self-abstracted sources. Distributed water is water supplied to a user, and where an economic transaction has occurred for the exchange of this water. Self-abstracted water is water extracted directly from the environment for use (including rivers, lakes, groundwater and other bodies). There is also a growing use of reuse water in these industries. Reuse water is drainage, waste or storm water that has been used again without being first discharged to the environment.

- Mining consumed 321 GL in 2001-02, 1.7% of total Australian industrial consumption, and 413 GL in 2004-05, 2.5% of Australian industrial consumption.

Most water used in the mining industry is from self-abstracted sources. Water is often obtained from mine dewatering, which occurs when water is collected through the process of mining and mineral extraction, or rainfall, run-off and water infiltration. Mine dewatering is considered to be a self-abstracted water source for the mining industry in the water account. Water extracted from the mine site and discharged without being used in the production process is considered to be in-stream use.

- Manufacturing consumed 549 GL in 2001-02, 2.8% of total Australian industrial consumption, and 589 GL in 2004-05, 3.5% of Australian industrial consumption.

The manufacturing industry in Australia consists of the nine subdivisions shown in Table 3. Water use varies considerably between these subdivisions due to the different nature of the products manufactured.

Table 3. Manufacturing industry gross value added (CVM) and water consumption, 2004-05

Manufacturing subdivision	Gross value added (CVM) $m	Water consumption GL	GVA per GL of water consumed $m
Food, beverage & tobacco	19 195	215	89.3
Textile, clothing, footwear	3 195	15	209.6
Wood & paper products	6 870	99	69.3
Printing & publishing	10 419	6	1628.0
Petroleum, coal & chemical	14 717	70	209.3
Non-metallic mineral products	4 529	20	227.6
Metal products	17 770	146	121.5
Machinery & equipment	18 851	15	1224.1
Other manufacturing	4 283	2	2855.3
Total manufacturing	**99 688**	**589**	**169.2**

Reference year for chain volume measures is 2006-06
Sources: Water Account Australia 2004-05 (ABS cat. no. 4610.0)
Australian System of National Accounts 2006-07 (ABS cat. no 5204.0)

Electricity and Gas

Electricity generators are a significant user of water in Australia. Most of the water is used for hydro-electricity power generation, but coal-fired power stations also use considerable amounts of water in their boilers and cooling towers. Water used for hydro power generation is not considered a consumptive use as the water extracted passes through turbines to generate electricity and is discharged and made available to downstream users; this is called an 'in-stream' use. Water consumption by thermal electricity generation is largely due to evaporation from cooling towers.

While it is clear that electricity producers are often significant users of water, it is also true that water availability is an important influence on how electricity is produced. For example, during Australia's current drought, concerns have been raised about the capacity of some hydro power producers to maintain base load electricity supplies. Water accounts can provide a basis for an informed assessment of whether water flows are sufficient to meet current and expected future needs of power generators. Table 4 shows the amount of water used and electricity generated by different fuel types in Australia in 2004-05.

Table 4. Water use and electricity generation by fuel type, 2004-05

Fuel type	Water use	Electricity generation	Water use per GWh of electricity generated
	ML	GWh	ML/GWh
Hydro	59 867 227	15 991	3 744.0
Black coal	153 021	102 180	1.5
Brown coal	81 887	54 041	1.5
Gas	11 606	20 786	0.6
Other	810	1 473	0.6
Total	**60 114 551**	**194 471**	**309.1**

Source: Water Account Australia 2004-05 (ABS cat. no. 4610.0)

In Australia, any shortfall in the capacity of hydro power producers to meet base load electricity demand will likely need to be met, in the short term at least, by additional electricity production from thermal producers, with consequent increased greenhouse gas emissions. But, as shown in the water account, coal-powered electricity production is also a significant user of water. An increasing scarcity of water may add to existing pressures to explore and adopt less water-intensive energy sources, such as wind, tidal, solar, biomass and geothermal.

There are few options for development of hydro power generation in Australia, especially at prevailing electricity prices. Tasmania, the smallest state, produces most of Australia's hydro power by utilising its relatively abundant water resources and its suitable terrain. Hydro accounts for around 90% of total power generation in Tasmania. New South Wales (NSW) generates the second highest amount of hydro power, but this accounts for only 8% of total electricity generated in NSW. Most of NSW's hydro power is generated in the Snowy Mountains, part of the Murray-Darling Basin, which has been severely drought affected in recent rears.

Water accounts can point up some of the regional differences in the mix of fuel types used for electricity generation. Table 5 illustrates the regional breakdown of electricity generation by fuel type in Australia.

Table 5. Electricity generation GWH by fuel type, States, Territories and National, 2004-05

	Hydro	Black coal	Brown coal	Gas	Other	Total
New South Wales	4 596	54 231	-	1 182	820	**60 829**
Victoria	794	-	49 341	1 179	-	**51 314**
Queensland	826	38 290	-	4 145	231	**43 492**
South Australia	-	-	4 700	5 401	38	**10 139**
Western Australia	215	9 659	-	6 117	110	**16 101**
Tasmania	9 560	-	-	934	226	**10 720**
Northern Territory	-	-	-	1 828	48	**1 876**
Australian Capital Territory	-	-	-	-	-	**-**
Australia	**15 991**	**102 180**	**54 041**	**20 786**	**1 473**	**194 471**

Source: Water Account Australia 2004-05 (ABS cat. no. 4610.0)

Water supply, sewerage and drainage

Water accounts have a valuable role to play in assessing potential impacts of climate change on the water supply industry. In a setting of likely increasing water scarcity there will be pressure on this industry to innovate and improve the efficiency of water supply and use. Water supplied by the water supply industry, by water type for 1996-97, 2000-01 and 2004-05 is shown in Table 6.

Table 6. Water supplied by the Water supply industry, by type, 1996-97, 2000-01 and 2004-05

	1996-97		2000-01		2004-05	
	GL	%	GL	%	GL	%
Distributed	11 525	98.9	12 934	96.2	11 337	96.4
Reuse	134	1.1	507	3.8	425	3.6
Total	**11 659**		**13 441**		**11 762**	

Source: Water Account Australia 2004-05 (ABS cat. no. 4610.0)

Reuse or recycled water is considered an important option for securing water supply into the future. There are a variety of water sources that may be supplied as reuse water, including waste water (from sewerage systems), drainage water, storm water or other water providers (i.e. a 'bulk' reuse water supply). There is increasing investment in infrastructure related to the supply of reuse water, and as such there is considerable interest in the volumes of reuse water supplied and used. In addition, water management authorities are interested in whether reuse water is reducing the demand for distributed water or self-abstracted water. Water accounts provide information to assist policy development in this area.

Between 1996–97 and 2000–01, the supply of reuse water increased from around 1% of total supply to nearly 4%. It decreased slightly from 2000–01 to 2004–05, largely due to the decrease in drainage water supplied as reuse water by irrigation/rural water providers (from 423 GL to 280 GL). This decrease was due to lower water availability caused by below average rainfall.

Water accounts also draw attention to distribution losses incurred by the water supply industry (which includes sewerage and drainage services) and provide a basis for assessing improvements in distribution efficiency. For example, the Australian water accounts recorded distribution losses of 2,022 GL (18.1%) of the 11,160 GL self-abstracted by the Water supply, sewerage and drainage services industry in 2004-05. This compares with distribution losses of 2,117 GL in 2000-01, 16.3% of total self-abstracted water (12,915 GL).

Water accounts can also facilitate comparisons of returns on infrastructure assets owned by the Water supply industry with the value of these assets. In a commercial operation, if the price of water supplied does not deliver a competitive return on the value of infrastructure assets used, the water supplier has little incentive to invest in additional infrastructure. Ultimately, investments to improve infrastructure are required to deliver improvements in water supply and use.

Households

Households used 23% of distributed water in Australia in 2004-05, but paid 61% of the total cost of this water.

Water accounts can tell us a great deal about household responses to changing climate patterns. Even in the short period between 2000-01 and 2004-05, Australian households made quite significant changes to their consumption of water, as illustrated in Table 7.

Table 7. Household water consumption, Australia, 2000-01 and 2004-05

	Household water consumption GL		Household water consumption, per capita Kl/capita	
	2001-02	2004-05	2001-02	2004-05
Household consumption	2 278	2 108	120	103
Change over period	-	-7.4%	-	-14.2%

Source: Water Account Australia 2004-05 (ABS cat. no. 4610.0)

The reduction in household water consumption from 2000-01 to 2004-05 was due to a combination of factors. The continuing drought throughout much of Australia saw most of Australia's capital cities introducing mandatory water use restrictions during this period, generally curtailing use of distributed water on home gardens and lawns. At the same time water providers conducted effective information campaigns to educate users about water conservation practices. Increasing numbers of households installed rainwater tanks to collect water, often supported by government rebates, as well as initiating water conservation practices in and around their dwellings. The proportion of households using recycled or reuse water within and around their dwellings increased from around 11% in 2001 to 16% in 2004. Reuse water used by households increased from 167 ML in 2000-01 to 1,767 ML in 2004-05.

In addition, most of Australia's urban water suppliers have moved to full cost recovery for provision of water supply services, increasing the price of water to households. While the link between increased price and reduced demand (due largely to the effect of mandatory water restrictions) for household water over this period is not entirely clear, increased prices do signal that excessive water consumption will continue to be expensive for households.

The water accounts also provide a regional perspective on water consumption by households. Table 8 illustrates the differences in household water consumption across the Australian states and territories, and changes in water consumption patterns between 2000-01 and 2004-05. Tasmania was the only jurisdiction where household per capita water consumption increased during this period, indicating that the drought affecting most of mainland Australia was not a major concern for households in Tasmania.

Table 8. Household water consumption per capita (Kl/capita) 2000-01 and 2004-05

	2000-01	2004-05	Change over period
New South Wales	97	84	-13%
Victoria	97	81	-16%
Queensland	143	124	-13%
South Australia	110	94	-15%
Western Australia	191	180	-6%
Tasmania	125	143	+14%
Northern Territory	162	153	-6%
Australian Capital Territory	115	95	-17%
Australia	**120**	**103**	**-14%**

Source: Water Account Australia 2004-05 (ABS cat. no. 4610.0)

Regional water accounts

The precise effects of climate change on hydrological systems are difficult to anticipate; therefore statistical agencies need to be flexible in how water accounts are presented.

For example, the Murray-Darling Basin (MDB) is Australia's largest catchment area and is vitally important to Australian agriculture, contributing some 45% of Australia's gross value of irrigated agricultural production in 2004-05. In 2005-06, farmers in the MDB used around 69% of the total water used by Australia's agricultural industry. The MDB spans parts of New South Wales, Victoria, Queensland, and South Australia, as well as the entire Australian Capital Territory. This means that characteristics of water supply and use within the MDB are not apparent from 'standard' Australian water accounts, which are produced in respect of the nation and for each of the states and territory. The Murray-Darling Basin Commission (a government authority with responsibility for the MDB) notes that several studies[3] claim the future climate of the MDB will be characterised by higher temperatures and reduced rainfall, resulting in reduced inflows to reservoirs and increased evaporation.

[3] http://www.mdbc.gov.au/nrm/risks_to_shared_water_resources#Climate_Change

Given the importance of the MDB and its expected vulnerability to climate change, the ABS will shortly release a study focussing on water supply and use in the MDB. The study will provide a detailed picture of the major users and uses of water, as well as analysis of the relationships between rainfall, water storage and water use in the MDB. This study is a clear example of a flexible and responsive approach to linking water accounting and climate change.

Monetary water accounts

Information on physical water flows and stocks can be combined with relevant monetary information into hybrid water accounts (as in Table 1), creating powerful analytical tools. Where climate change increases water scarcity, water pricing and trading strategies can be used to encourage more efficient water use to ensure that water is allocated where it adds most value. Water accounts can be used to chart changing patterns of water use associated with evolving water pricing and trading policies, particularly when such policies target specific sectors of the economy. For example, the Australian government's recent *National Water Initiative*[4] recommended that water distributed to urban users should be priced to achieve full recovery of all costs associated with its capture, storage, treatment and distribution, while water distributed to rural and regional users should be priced to cover only current costs associated with supplying water. Effects of the progressive adoption of these pricing policies will be captured in national and regional hybrid water accounts.

In the past, water allocation in Australia was largely based on a series of administrative systems anchored in incremental allocation and 'first in' principles. These systems lacked the flexibility and functionality needed to respond to changing climatic conditions and changing markets. Now, trading is the primary means of reallocating available water resources among users. Trading may involve a reallocation of water within or between sectors, regions and communities. The ABS produces statistics on trading in entitlements to access water as well as on trading of water parcels—statistics that can be integrated into water accounts.

Water trade information can be a valuable monitoring and policy tool when incorporated into water accounts. For example, rapidly rising water trade prices provide an early and clear indicator of increasing scarcity of water available for production. In addition, ABS water trade data contain information on 'permanent' trade of water rights (i.e. sale of on-going access to a body of surface or ground water) and 'temporary' trade of water rights (sale of one year of access to a body of surface or ground water). If prices of temporary and permanent access rights to a specific water system converge over time, this would indicate a weakening of confidence in the long term availability of water for that system.

Water trade information can also answer questions about the effectiveness of institutional arrangements. For example, we could ask whether volumes of water traded are increasing as a proportion of total water used within the economy. If not, this would suggest that the existence of water trading is not having a material influence on the allocation of water. This may prompt action to seek and remove remaining obstacles to water trading and to encourage innovation in the design and delivery of water trade products.

[4] National Water Initiative (2004), *Intergovernmental Agreement on a National Water Initiative*

Under ‘normal’ climatic conditions, if water prices move from essentially ‘free’ levels to levels where some producers begin choosing not to purchase water, we would expect to see water increasingly being used by those producers who are able to add greater value to water inputs. In ‘normal’ droughts, we might expect to see farmers purchase water to preserve their valuable long-lived assets, such as grape vines and fruit trees, while water intensive annual crops, such as cotton and rice, may be abandoned until water becomes more plentiful and water prices fall. This behaviour reflects the considerable cost in allowing valuable assets to perish, so farmers will incur relatively greater costs and effort in the short term to preserve these assets for the long term.

However, for extended or permanently dry conditions, which may become the case with climate change; a producer may cease to be economically viable if obliged to pay higher water prices indefinitely. It is quite possible; even likely, that a significant impact of climate change in Australia will be reduced water availability in the MDB. Under these scenarios, if the producer cannot generate an adequate return at higher water prices, their response will be to either: change to a less water-intensive type of production; change to a higher value adding form of production; or cease production. Water accounts can capture such changes in water pricing and their associated impacts on agricultural and other economic production.

Monetary water accounts can also shed light on the cost/benefit of potential alternatives to supplying water harvested from local streams and aquifers. Urban water suppliers in Australia have either commenced or considered sea water desalination to supplement traditional water sources. Water accounting will help to establish the viability of providing desalinated water to meet urban household and industrial demand, and the potential to supply desalinated water for agriculture.

Most of Australia’s population live on the coastal fringes in the south and east of the country, while most rain falls in the north of the country. Proposals have been made to pipe water from where it falls in the north to where it is needed by the population centres of the south and east. Water accounts can help to inform policy response to these proposals.

Conclusion

The late Professor Peter Cullen, National Water Commissioner and Member of the Wentworth Group of Concerned Scientists remarked on the importance of water accounting, ‘Flying blind hasn’t worked and we must know how much water we have, where it is and how it is being used.’[5]

Water accounts will contribute to our understanding of climate change and help inform our response to this challenge, but, as for other impacts of climate change on the environment, more information is vital. Returning to the introductory message of this paper: ‘If you don’t measure it you won’t understand it.’ So it is with water.

[5] Cullen, P., cited in *Droplet No. 11*, The University of Adelaide, March 2008

References

Australian Bureau of Statistics, *Water Account Australia 2004-05*, Cat no. 4610.0

Australian Bureau of Statistics, *An Experimental Monetary Water Account for Australia, 2004-05*, Cat no. 4610.0.55.005

Australian Bureau of Statistics, *Australia's Environment Issues and Trends, 2007*, Cat no. 4613.0

Australian Government, Department of Climate Change, *Climate Change Impacts and Adaptation* (www.greenhouse.gov.au/impacts)

Australian Government, Murray-Darling Basin Commission, *Risks to Shared Water Resources* http://www.mdbc.gov.au/nrm/risks_to_shared_water_resources#Climate_Change

Cullen, P., in *Droplet No. 11*, The University of Adelaide, March 2008

Coughlan, M., and Vertessy, R., Australian Government Bureau of Meteorology, presentation to Australian Bureau of Agricultural and Resource Economics (ABARE) Outlook Conference, Canberra, 2008.

National Water Initiative (2004), *Intergovernmental Agreement on a National Water Initiative*, 25 June 2004, Commonwealth of Australia

Price Waterhouse Coopers and the Department of the Prime Minister and Cabinet (2006), *National Water Initiative Water Trading Study Final Report 2006*, July 2006.

United Nations Statistical Division, *Integrated Environmental and Economic Accounting for Water Resources, Draft for Discussion*, 2006

Eva LACZKA – Tibor FARAGO:

Climate Change Policy and Need for Adequate Statistical Information with Special Regard to Agriculture

Nowadays, climate change is a highly debated topic at both national and international forums.

The hazard of the global climate change, its anticipated implications and the necessary response measures have become the most crucial themes for environment related scientific and policy studies. The increasing scientific evidence of this process and of its anthropogenic forcing factors strongly motivated the politicians to face this challenge, to accept the "common but differentiated" responsibility for this emerging global hazard and to agree on the need for the coordinated actions. As a result, the UN Framework Convention on Climate Change (UNFCCC) was adopted in 1992 followed with the Kyoto Protocol five years later. Besides these international legal agreements, the various commitments and provisions included in them, regional and national level strategies and action plans have been developed. All these legal and policy instruments basically deal with two - partially interrelated - areas, namely, with mitigation policies and adaptation policies.

Adequate analytical background is a significant prerequisite for these policy responses for various reasons. Firstly, clear knowledge on the ongoing environmental pressures, primarily in terms of increasing atmospheric concentrations and emissions of the greenhouse gases (GHG), moreover, the detailed information on their natural and man-made sources are needed for improving detection and understanding of the extent of the problem. As there is a multitude of socio-economic activities with such emissions, only a rather punctual description of these activities and their changes can provide good basis for the formulation of effective mitigation policies. Besides the past and ongoing processes and their driving factors, assessment of the expected future behavior of these factors is also needed for the policy-makers. Secondly, the impacts of the global climate change should be described and/or assessed on various time horizons in order to develop the relevant adaptation responses. In this context, the availability of and access to proper statistical information for all related sectors and sub-sectors are significant on both sides of this complex issue, i.e., for the socio-economic activities, which are responsible for the GHG emissions and also for those areas, which are primarily affected by changes of the climatic (and the related environmental) conditions.

The investigation on climate change, its expected national level impacts, the main domestic sources of the GHG-s and the development of various policy options have been dealt with in Hungary since 1980s to a gradually increasing extent. These activities were intensified from the early 1990s in line with the international tendencies.

The anticipated effects of the climate change have to be taken into consideration both on the long and short terms. Already today the negative consequences of the constantly changing and often extreme meteorological and hydro-meteorological patterns are financially significant; the cost of rescue, reconstruction and prevention could be as much as one percent of the GDP. Annually on the long run climate change will adversely effect the environment, the overall health of our society and some key socio-economic sectors.

1. The premise of the Hungarian Climate Change Strategy

The Hungarian climate change related research runs back over 25 years. At the beginning the observation of domestic trends and their relations to global average surface temperature tendencies, furthermore complex data collection for better identification of the trends in climate parameters were in the focus of research.

During the second half of the 1980s the first complex studies about the effects of sustained draughts and extreme weather patterns in relation to expected climate change were done. The first thematic monographs on climate change related national research were published in 1990 and 1991 thanks to the support of the Ministry of Environment in course of preparation for the Rio Summit (UNCED).

Based on the previous research studies, first national general policy studies were developed for the sake to support the position setting for the international negotiations before 1992. From that time period on, the climate change related aspects were increasingly taken into account in various strategic documents and program, such as for instance, in the first National Environmental Program (NEP, adopted in 1997) and in the second NEP, six years later.

A project called „Global climate change: domestic issues and solutions" based on previous studies have been launched in 2003 as a cooperative effort between the Ministry of Environment and Water and Hungarian Academy of Sciences. Scientists and experts involved in the project have tried to predict the future patterns of domestic climate change, and its effects on certain sectors, as well as look for economic, social and political solutions. During the three-year course of this project relevant data, most significant international literature, other research findings, and agreements had been studied and evaluated.

The above mentioned three years' research program on the impacts of the climate change provided an even deeper basis for a new, comprehensive policy paper: the National Strategy on Climate Change that was just recently adopted by our National Assembly.

2. Purpose, fundaments and priorities of the Hungarian National Climate Change Strategy

When looking at the domestic consequences of climate change the globally predicted temperature rise of 2-2,5°C is an acceptable value of reference. The dual purpose system of the strategy covering both the decrease of greenhouse gas emission and adaptation to unavoidable changes had been designed using this scenario.

The overall purpose of the NCCS is to contribute to the national effort of decreasing the chance of a 2-2,5 ºC rise in average temperature; furthermore to help national environmental, social, and economic organizations to prepare for and adapt to the consequences of climate change.

The NCCS defines a triple priority system to deal with and solve the problems of climate change:

- Perception (calling in social and professional partners)
- Mitigation (achievable emission reduction)
- Adaptation (preparing for adaptation)

Although the Hungarian Climate Change Strategy deals with the impact of water management, agriculture, human health, and urban environment on the climate change, this study only focuses on the effects of and issues related to crop farming, animal breeding, forested and green areas.

3. Main characteristics of the Hungarian agriculture

Agriculture has always played a significant role in our country's economy in the past and even today. The size of cultivated agricultural land area is about 63 percent of the total land area, while 5 percent of the active earners are employed in agriculture. The share of agriculture in the Gross Domestic Products (GDP) is about 4 percent, and that of the food industry is more than 6 percent.

In the past fifteen years fundamental changes have taken place as regards the ownership and the structure of agriculture in Hungary. Previously a relatively small number of large-scale agricultural and food-industrial holdings were operating. After the privatisation of the land area, state farms and agricultural co-operatives were subdivided and a large number of small and medium size agricultural units were established.

According to the Farm Structure Survey 2005, 7 900 agricultural enterprises (business units) and 707 thousand private holdings were engaged in agricultural activity in Hungary.

The average size of the productive land area[*] used by agricultural enterprises was 487 hectare; the same value of private holdings was hardly more than 3.4 hectare. While 22 percent of agricultural enterprises used productive land area of size exceeding 300 hectare, 73 percent of the private holdings continued to cultivate productive land area below 1 hectare size.

26 percent of agricultural enterprises and 53 percent of private holdings were involved in animal breeding. 90 percent of the livestock of agricultural enterprises constituted of 2 species (cattle and pigs), in contrast to private holdings, where four species including pigs, cattle, sheep and horses amounted to the same figure.

The attributes of holdings by type of farming are also at variance. In 2005, 74 percent of the agricultural enterprises were engaged in crop farming, 9 percent in livestock farming, and 17 percent in mixed farming. In case of private holdings 47 percent of them were involved in crop farming, 21 percent in livestock farming, and 32 percent in mixed farming.

In 2005 the purpose of production of private holdings were also surveyed. That time 51 percent of the private holdings produced exclusively for own consumption, while the share of private holdings producing for market was only 15 percent. 33 percent of private holdings produced for selling the surplus. Production exclusively for own consumption was mainly

[*] Arable land, kitchen garden, orchard, vineyard, grassland, forest, reed, fishpond

typical for private holdings engaged in livestock farming (78 percent), whereas the share of production for market was the highest in case of crop farming (22 percent).

3.1. Land use – crop production

Crop production accounts for 60 percent of the total agricultural output.

83 percent of the country's area is used as productive land area, while 17 percent is out of agricultural production. The size of agricultural land (arable land, kitchen garden, meadow, pasture land, orchard, and vineyard) totals 5.8 million hectares; 19 percent of the country's area is forest, and 1 percent is reed and fishery.

In 2005, the total size of arable land exceeded 4 million hectares (49 percent). Two thirds of the crops seeded are cereals. In addition to cereals industrial crops (18 percent), forage crops (6.6 percent), potato and vegetables (combined 2.5) are produced.

The total area of orchards is 103 thousand hectares, in which apple is dominant (45 thousand hectares). Over the apple, sour cherry (13 thousand hectares) and plum (9 thousand hectares) are the most common orchard species. The total area of vineyards is about 84 thousand hectares of which 81 thousand hectares of grape were produced for wine making.

11 percent of the country's area is grassland.

3.2. Animal breeding

Animal breeding produces about 40 percent of the total agricultural output.

In the livestock unit composition cattle (42 percent) and pig (32 percent) aggregate the largest share; while poultry (14 percent), sheep (8 percent), and horse (4 percent) stocks are less significant.

The size of cattle stock was 702 thousand as of December 2006. 34 percent of the farms kept 1-2, 45 percent 3-9, 18 percent 10-99, and 3 percent more than 100 cattle. At that time the size of pig stock was 4 million. 64 percent of the farms kept 1-2, while 0.3 percent kept more than 100 pigs. The sheep stock was 1.3 million. 60 percent of the farms kept 1-9 sheep while the share of big sheep farms (breeding more than 100 sheep) was just 12 percent. The number of chicken was 30.3 million, 58 percent of the farms kept less than 100 chicks. The share of big chicken farms was 20 percent. Number of horses just was 60 thousand.

3.3. Forested and green areas

71 percent of the total 1.9 million hectares of forested area is covered by deciduous, hardwood; 13 percent by softwood; and 16 percent by pinewood. 24 percent of growing stock is oak, 13 percent is turkey oak (Quercus cerris), 12-12 percent is beech and locust, and 10 percent is pine; 42 percent of the forest is older than 40 years.

The green area of settlements covers about 40 thousand hectares. The neatness of public parks and premises greatly vary from settlement to settlement, and even between districts of cities. The size of these areas is constantly decreasing due to continuous real estate developments. However, when well maintained, these areas have a perceptible, positive effect on the microclimate of a given area. Forested areas near settlements provide good facilities for outdoor and sport activities.

4. Interaction between climate change and agricultural production

4.1 The effects of climate change on crop production

In the case of crop farming, a noteworthy effect of climate change is the more frequent extreme weather patterns. Flooding, flesh flooding, inland inundation, increasing wind speed, damages caused by hail, early and late frosts, extreme heat, and droughts are negative effects to be taken into consideration. Due to the uneven changes of seasons, the natural balance of the environment will be disturbed affecting all living creatures from micro-organisms to pests.

The area of Hungary is considered to be prone to droughts. There had been 28 years of droughts in the last century. 40 percent of all insured damages were related to drought which decreased agricultural revenues by 10 percent on average.

Damages caused by hail accounted for one fifth of all insured damages in the last 35 years.

In addition to damages caused by flooding, it has often happened over the last 20 years that years with excess water and rain were followed by droughts. Therefore, extremes in water supply created a serious economic risk. Flood and inland inundation damages combined accounted for 18 percent of all insured agricultural damages. Depending on annual rainfall and flooding, the size of area damaged by inland inundation was around 100-150 thousand hectares of agricultural land.

Erosion damages caused by flesh flooding affected 40 percent of Hungary's agricultural land. Furthermore, erosion had also damaged the infrastructure of industrial and municipal areas.

Extreme winds have negatively affected all agricultural areas. The most common effects caused by high winds are: mechanical damages, soil erosion, crop damages, etc.

In addition to the extreme weather patterns, the dominance and spread of invasion species such as pests and weeds is expected.

4.2 The effects of crop production on climate change

Out of the three most important greenhouse gases – carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) – crop farming significantly contributes to the nitrous oxide and methane emission.

Most of the nitrous oxide comes from the soil, part of it from nitrogen fertilizers (9 percent) and the other, larger part from denitrification (88 percent). These two are closely related since the use of nitrogen fertilizers increases denitrification. The largest methane emitter is also the soil, because methane is generated when organic materials used during cultivation decompose without oxygen.

4.3. The effects of climate change on livestock breeding

The climate change has different effects on animal breeding based on the type of animal kept. While the intensive type of stock is more sensitive to climate change, extensive animal breeding is less seriously affected and damages are moderate. Intensive pig, cattle and chicken farms are more sensitive to climate changes and have significant productivity decrease when experiencing any kind of negative shock.

Traditional extensive type of animals such as the „Hungarian Grey Cattle", „Mangalica Pig", „Racka Sheep", and „Parlagi Chicken" are able to adapt better due to their genome and extensive raising. Therefore in the breeding process, in addition to productivity and quality, it is important to favour species which are able to adapt easier to climate change. Furthermore, farming and animal keeping conditions should be proactively improved.

As a result of climate change, the livestock's water and shade requirement increases which needs extra care and attention. The adaptability could be improved by purposeful breeding.

Extensive or natural animal breeding could be affected by climate change when the grass composition of pasture land changes in favour of xerophilous species with different nutrient content.

4.4. The effects of livestock breeding on climate change

Animal breeding significantly contributes to the carbon dioxide and methane emission.

In case of carbon-dioxide, most of the gas emission (82 percent) is produced during the natural respiration of domestic and wild animals.

In terms of the sources, the methane emission is probably the most complex. Methane emission coming from the fuel consumption of agriculture is not significant (0.05 percent). Soil emits the largest quantity of methane because it is generated when organic materials used during cultivation decompose without oxygen. Animal breeding also has a significant contribution to methane emission, since the digestion and respiration of livestock produces 31 percent of the total methane emission. Methane coming from the digestion and respiration of wild animals is insignificant (1.5 percent).

4.5. The interaction between climate change and forested, green areas

As a result of global warming, spring budding could happen 40 days earlier which in addition to other consequences could have unforeseeable effects on disease control.

Climate change could negatively affect all domestic forests. If the frequency and length of droughts will increase, then more frequent and severe pest damages are likely to happen. New, less known, or „long forgotten" pests will damage the forested and green areas.

Even in currently favourable areas, decreased rainfall during growing seasons will lead to less growth which will lower the amount of carbon-dioxide absorbed. The shortage of precipitation will also hinder the planting and replanting of forests.

According to expert studies, forested areas first stricken by increased temperatures will be forests in the Great Plain, forests of turkey oak and penduncule oak in the Transdanubian region, and beech.

In addition to the decreased amount of wood lumbered, higher temperatures could lead to frequent forest fires, especially if they are caused intentionally or by negligence. Higher occurrence of fires negatively influences the structure of vegetation and production site, as well.

The situation of existing or potentially creatable green areas in terms of endangerment is similar to the forested areas, whereas these areas are very important to compensate for the „heat islands" developing in urban areas.

5. Adaptation

5.1. Crop production

The NCCS proposed to decrease nitrous oxide and methane emissions by introducing water efficient and soil preserving growth methods.

Better breeding techniques, proper species selection and cultivation methods could decrease the adverse effects of crop farming to climate change. The strategy proposes the proper funding of cross breeding.

Development and implementation of cultivation methods serving better adaptation (precise pest control and fertilization, efficient watering equipments, methods preventing inland inundation and drought damages) are also considered to be effective tools according to the strategy.

Further research should be done to find out how energy crop production will influence climate change.

In order to limit the spread of invasion species successfully, the strategy suggests including relevant research in the agricultural policy.

5.2. Livestock breeding

The principal objective of adaptation is the technological improvement of livestock keeping and breeding.

The preference of breeds which are more able to adapt to different conditions improves cost efficiency and the genome of livestock. The development of information and insurance support system is a prerequisite of a production method which could capitalize on the advantages of climate change.

According to the NCCS, in addition to the suppression of invasion species, quality and productivity should be in the focus of breeding. Based on the results of different adaptation researches, selection of breeds more able to adapt to climate change could be an efficient tool.

According to the NCCS, governmental subsidies and improved extensive animal breeding conditions are essential in order to increase the number of native species. In the case of intensive animal breeding, development of technologies based on renewable energy could decrease the adverse effects of climate change.

The environmentally sound treatment of manure and the use of renewable and green energy sources are important issues when it comes to sustainable animal breeding.

As stated in the NCCS, the first step towards the environmentally friendly production is the development of a tender procedure which subsidizes the collection and utilization of biogas.

5.3. The effect of forested and green areas on climate change - adaptation

The vegetation cover, in particular, the forest covered land areas play an extremely important role in the natural carbon cycle. Forests act as sinks of the atmospheric carbon dioxide and changes in their sink capacities influence the atmospheric concentration of this greenhouse gas (GHG) to a large extent. Forestation, reforestation, deforestation and better forest management are all taken into consideration in this regard and all these activity areas are subjects to the international cooperation and to the national climate change policies. In Hungary, the sink capacities of various forest areas have been investigated for quite a long time (field measurements and analytic studies) and the derivation of the relevant parts of the national emission inventories have significantly improved due to these research activities and the improved statistical information.

Forests should also be considered as a key climate change impact area where first of all the expected adverse effects have been estimated and those measures were identified which lessen the vulnerability of the forest cover to the anticipated changes in the climatic conditions.

According to the NCCS regulations applying to forests, energy and sewage treatment plantations should be dealt with separately and individually. Establishing an information system monitoring climate change would be the first step towards this goal.

Preserving or even increasing the size of forested and green areas could help to improve adaptability. The review and aggravation of biodiversity preservation requirements and the incorporation of adaptation strategies to the national forest program are important issues which should be addressed.

Issues of climate change requiring special emphasis:

- forest management taking forest dynamics and constant stock capital into account;
- planting species suitable for the new conditions resulted by climate change;
- analysing the impact of energy source plantations.

Preservation and expansion of green areas in urban regions, creation of new green areas with species native in warm South-European regions are important aspects of the climate change strategy.

6. Main characteristics of the Hungarian System of Agricultural Statistics

Regular agricultural statistical reporting looks back to nearly 200 years of history in Hungary. Agricultural surveys of the first half of the 19th century covered only some indicators of production. A vital change took place in 1895 at the time of the first agricultural census, when the data collection covered all agricultural units in the country. An attempt to conduct crop production statistics was made in the framework of censuses of 1895 and 1935.

After World War II, the Hungarian Statistical Office was restructured, including the system of agricultural statistical surveys. Though certain reports were made regular and were done more often than earlier, the census remained awaited for long. Although the issue of joining the global agricultural census of FAO was raised in the fifties, the survey was postponed. Since the investigation of some particular issues could not be put off, an orchard census was conducted in 1959, followed by the census of agricultural machines and equipment in 1960, and the nationwide vineyard census in 1965. Without the regional divisions of the Hungarian Central Statistical Office created in 1952, the surveys mentioned above could not have been completed.

In the sixties the structure of Hungarian agriculture underwent a radical transformation as a consequence of the rapid growth of collective farms. With the stabilization of accounting and reporting system, detailed and accurate statistical information was available on state farms and co-operatives, while no reliable data were available on the private holdings destined to be phased out.

The first full-scale agricultural census of the 20th century took place in 1972. The surveys provided information on a number of earlier unknown features of agriculture, specifically with respect to small-scale production.

In the second half of the 20th century, the 10-year censuses became regular; moreover, information such as the vital statistics of small-scale producers was collected in 1976 and 1986 in the framework of the livestock census to satisfy the needs of domestic institutions and the five-year reporting to FAO.

The findings of the agricultural census 1991 took a snapshot of Hungarian agriculture at the time of the change of the political and economic system. The agricultural census 2000 mirrored the pre-accession condition of Hungarian agriculture in accordance with the methodology and standards of the EU System of Agricultural Statistics.

Apart from the censuses, one should also take into consideration the regular agricultural surveys. The annual regular surveys are built in each and every case on the results and data of the preceding agricultural census. The key feature of these surveys is that they typically covered the forms of business that were deemed dominant in agricultural production.

The changes of System of the Agricultural Statistics have always reflected the structural changes of the Hungarian agriculture. Up to 1990, only state enterprises and co-operatives were obliged to report data and in case of households, data collections only concerned their livestock. From 1957, beside the annual livestock survey, representative livestock surveys were conducted on households in every four months. Only censuses provided data for land use and crop production of the previously mentioned units.

In the nineties, fundamental changes have taken place as regards the ownership and the structure of agriculture in Hungary. Over the previous decades, a relatively small number of large scale agricultural and food-industrial holding were existing. In the early nineties, the land area of state farms and co-operatives was subdivided and a large number of small and medium size agricultural units were established on which far less data were available. Therefore, since 1991 the land use and crop production of the households have become subject to sample surveys. Nowadays, the Agricultural Censuses and surveys cover 99 percent of the output of agriculture.

The Hungarian Central Statistical Office conducts 15-20 agricultural statistical surveys each year. These surveys belong to two distinct groups: agricultural production statistics, and the surveys to meet the needs of the Economic Accounts for Agriculture.

7. Existing data sources – problems

The examination of the impacts of climate change in Hungary has a 25-year history. Nevertheless, a general characteristic of the research is that the examinations cover only certain sub-regions or sectors, not covering the whole territory of the country or the whole economy.

For instance, the Corvinus University of Budapest works on a database, which will provide data on the interaction between vineyards and climate change. The Hungarian Academy of Sciences examines local impacts of climate change in some selected settlements as well as factors influencing climate change.

In the last two years, the work has been accelerated; for the coordination of researches a new project “Environment-Risk-Society” was established. What is more, during two years, 299 publications have been published concerning climate change in thematic brochures designed for that purpose.

Although the above mentioned publications deal with certain fields of environment, economy and society as well, they basically examine the interaction between climate change and the agriculture, for instance:

- importance of adapting soil cultivation methods in soil protection practice;
- effects of climatic conditions on maize production;
- impacts of climate change on winter wheat growth.

This is the reason why this paper focuses on the interaction between climate change and the agriculture while observing data sources.

According to national experience, the following main groups of indicators could be mentioned:

- meteorological data;
- physical parametres of surface;
- data on environmental elements;
- production data;
- emission data;
- immission data.

The output of agricultural production is basically determined by the changes of weather year by year. In case of examinations, it is necessary to take into account the changes of temperature, sunshine duration, quantity and distribution of precipitation etc. It is important to know in which season the crop production was stricken by drought. Fortunately, a 100-year long meteorological time series is available in Hungary.

Data on land use according to cultivation methods, results of crop production (sown area, amount of yield, average yield) are available since the year of 1895. The same length of time series is available for the number of livestock.

Nowadays, data are available on annual basis concerning crop production and on four-month basis concerning livestock. The weakness of data collections is that they cover neither the species of crops and animals nor the quantity characteristics of the production. Furthermore, it is considered as another weakness that the sample surveys can provide reliable data only at regional level.

The only exception is the full scope basic survey on vineyards and orchards carried out in 2001 that accounted the types of grapes and fruits, as well as the cultivation methods of the plantations.

Concerning irrigation, soil cultivation (nutrient supply), supply of manure and fertilizer, use of pesticides and production methods, only some aggregated data were available in the past few decades in Hungary. In order to solve this problem, basic changes are foreseen in the EU Member States. In 2010, the data collection of the Farm Structure Survey (FSS) will cover the production methods providing information for the evaluation of interactions between agriculture and climate change.

The production methods module is going to gather information on farming such as

- tillage methods;
- soil conservation, actions against erosion and nutrient leaching;
- landscape features, parameters;

- animal grazing;
- animal housing;
- nutrients;
- manure storage and treatment facilities;
- plant protection;
- irrigation.

The production method module of the FSS will be implemented linked to the agricultural production data by holdings. Therefore, the above mentioned survey data could become the most important input of climate change researches in the forthcoming years.

Estimated data on energy use of agriculture are available only at regional level. The quality of estimation can be developed by using administrative data sources. Measurement of energy efficiency of agriculture as well as involving renewable energy sources in the production are to be elaborated.

The operation of forestry statistics is the responsibility of the Ministry of Agriculture and Rural Development in Hungary. The aim of the Ministry is to record forest assets, forestation and yield, to describe the quantity and quality characteristics of timber stock, to provide detailed and updated information for the climate change research.

Hungary has been collecting data on green areas for 15 years; HCSO is responsible for it. The annual statistics is based on administrative data of local authorities, measuring green area within the territory of settlements. Regarding climate change research's needs, the weakness of data collection is the lack of information on the type of plant species within the green area and on cultivation methods applied.

As regard the emission data, under the UNFCCC, a complex methodology was elaborated in order to arrive at consistent and comparable national GHG emission inventories. The responsibility for compilation of emission inventory is delegated to the Ministry of Environment and Water. HCSO contributes with data of industrial and agricultural production. One of the most problematic areas in this regard is the derivation of emission factors for various soil types and plant species. Concerning soil types as well as the plant species, the Ministry of Agriculture and Rural Development is responsible for data collection. Measurement of immission is joint responsibility of the Ministry of Environment and Water and the Ministry of Public Health on certain environmental elements (air, soil, inland and ground water). 30-40 parameters of the environmental elements are observed by measurement point networks several times a year. In order to support the analysis of immission data, statisticians develop and provide mathematical statistical methods. Examination of the correlation between emission and immission data is to be elaborated.

8. Conclusion

The examination of the impacts of climate change in Hungary has a 25-year history. In the past two years, the work has been accelerated and the Hungarian Climate Change Strategy has been developed and accepted. Almost 300 publications have been released concerning climate change.

In order to coordinate the work, a forum was established; the main tasks of this forum are to compile the list of indicators, to define the existing data gaps, to elaborate methodology and definitions. Clear division of labour between the national statistical institutes, ministries and professional bodies is also required.

The Role of Official Statistics in Measurement of the Impacts of Climate Change: Indian Experience

Sourav Chakrabortty

Social Statistics Division, Central Statistical Organisation

Ministry of Statistics & PI, Government of India, New Delhi, India

Abstract

Climate is the long-term statistical expression of short-term weather which can be defined qualitatively as 'Expected Weather' or quantitatively by statistical expressions such as central tendencies and variances in key parameters. Changes in climate are the differences between the average conditions in terms of key parameters over time. There is broad consensus that major or minor climate change leads to many hazards and disasters viz increased flood, land slides, avalanche and mud slide damage, increased soil erosion, increased flood run of, increased recharge floodplain aquifiers etc. It also causes displacement of people and increased deaths and serious illness in older age groups and urban poor, increased heat stress in life stock and wild life, increased risk of damage to a number of crops, decreased crop yields, decreased water resource quantity and quality, increased risk of forest fires etc. Relating such disaster like events to climate change can provide robust basis for assessing the impacts of such changes. These would require availability of sound database on the indicators of climate changes and occurrences of disaster type events.

In India different Ministries/Organisations/Institutions measures and monitors some indicators of climate changes but as such there is no regular information on climate change induced events such as flashfloods. Central Statistical Organisation in collaboration of National Institute of Disaster Management initiated a joint exercise to develop a Disaster Statistics database. This database will be one which can help researchers and policy makers to assess the impact of climate changes on major or minor disaster. The database will contain data of both hazards and disasters. Some of these hazards and disasters are manmade while most of them are due to change of climate over a considerable period of time. This paper will try to highlight the progress of this endeavour and also will try to explore the possibilities of measuring the impacts of climate change on hazards and disasters.

1. Introduction

The term climate change is often used inter-changeably with the term global warming, but according to the National Academy of Sciences, “the phrase ‘climate change’ is growing in preferred use to ‘global warming’ because it helps convey that there are other changes in addition to rising temperatures”. Climate change refers to any significant change in measures of climate such as, temperature, precipitation or wind; lasting for an extended period say, decade or longer. Climate change may results from (a) natural factors, such as changes in the sun’s intensity or slow changes in the Earth’s orbit around the sun; (b) natural processes within the climate system such as changes in ocean circulation; (c) human activities that change the atmosphere’s composition (such as burning fossil fuels) and the land surface (deforestration, reforestration, urbanization, desertification). Global warming is an average increase in temperature in atmosphere near the Earth’s surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, ‘global warming’ often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities.

The climate system involves dynamic physical, chemical, and biological interactions between the atmosphere, hydrosphere, cryosphere (snow, ice, and permafrost on and beneath the earth and ocean surface), land surface, and the biosphere at varying temporal and spatial scales. Any factor affecting the balance between the incoming solar radiation energy and the outgoing terrestrial radiation, or the energy redistribution between atmosphere, land, and water can affect the climate. Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or more) (IPCC 2001). The earth’s atmosphere is primarily made up of three gases - nitrogen (78.09%), oxygen (20.95%), and argon (0.93%). However, it is the gases present in trace quantities such as CO_2, CH_4 (methane), NOx (oxides of nitrogen), CFCs (chlorofluorocarbons), and ozone that greatly influence the radiation balance of the earth and lead to the ‘greenhouse effect’. The increased concentration of GHGs (greenhouse gases) in the atmosphere enhances the absorption and emission of infrared radiation, leading to an ‘enhanced greenhouse effect’ over and above the natural phenomenon.

In every country development activities are measured in terms of national products, which in turn are defined as production of goods and services during accounting period. However, certain environmental functions, which are crucial for economic performance and generation of human welfare such as provision of natural resources to production and consumption activities, waste absorption by environmental media and environmental services of life support and other human amenities, are taken into account only partly in conventional accounting system. The scarcities of natural resources now threaten the sustained productivity of the economy and economic production and consumption activities. These activities impair environmental quality by over loading natural sinks with wastes and pollutants. The environmental consequence of development tends to offset many benefits that may be accruing to individuals and societies on account of rising incomes. There are direct costs on the health of individuals, their longevity and on quality of life. More importantly, the environmental damage can also undermine sustainable future attainments, if the factors of production are adversely affected. The environmental stress caused by developmental activities emanating from emissions and discharges of various substances into air, water and soil. These emissions and discharges not only have local effects but also have regional and global effects too.

The advent of Industrial Revolution extended the impact of human activities on the environment from a local to global scale. CO_2 concentration levels have increased by more than 30% compared to those during the pre-industrial times, and are continuing to increase on an average of 0.4% per year. Human activities, in particular those involving the combustion of fossil fuels for industrial or domestic use, and burning of biomass produce GHGs and aerosols which in turn affects the composition of the atmosphere. Although certain gases such as NOx and CO, emanating from agricultural, industrial, and other human activities, are not GHGs, they play a significant role in the atmospheric chemistry and have led to an increase in tropospheric ozone (a GHG) by 40% since pre-industrial times. CFCs and some other halogen compounds do not occur naturally in the atmosphere but have been introduced by human activities. These CFCs and other halogen compounds are GHGs and have depleted stratospheric ozone layer. Most of these GHGs have long atmospheric lifetimes hence their emissions today will have a lasting effect for much longer time (IPCC 2001).

Climate change causes geophysical effects such as more intense precipitation events; higher maximum temperatures, more hot days/ heat waves; higher minimum temperatures, fewer cold days, frost days/cold waves; increase summer drying and associated risk of drought etc. There is broad scientific consensus that more intense precipitation leads to increased flood, land slides, avalanche and mud slide damage, increased soil erosion, increased flood run of, increased recharge floodplain aquifiers. Higher maximum temperatures caused by global warming results in accelerated sea level rises threatening many low lying islands and coastal zones. It also causes displacement of people and increased deaths and serious illness in older age groups and urban poor, increased heat stress in life stock and wild life, increased risk of damage to a number of crops. Higher minimum temperatures results in decreased co-related human morbidity and mortality. It also causes damage to a number of crops and extended range and activity of pests and disease vectors. Increased summer drying results in decreased crop yields, decreased water resource quantity and quality, increased risk of forest fires. The geophysical effects of climate change individually and collectively results in increase in flood and drought magnitude/damages, decreased agricultural productivity in drought and flood prone regions, increased risk to human life and risk of infectious diseases, epidemics, increased coastal erosion and damage to coastal buildings and infrastructure. Major health impacts of climate change can be changes in the pattern of vector borne viral diseases.

The greenhouse effect

The atmospheric particles and gases absorb energy from the incoming solar radiation in different wavelength regions. Molecules emit lower energy than they absorb. Therefore, after absorption, the solar radiation is transformed and radiated back in the far-infrared region of the spectrum at longer wavelengths (lower energy). Gases such as water vapour, carbon dioxide, and methane trap the outgoing radiation in the far-infrared zone, except in a transparent par t of the spectrum called the 'atmospheric window'. They reradiate a large fraction of the heat wavelength downward, thus heating the earth surface (analogous to the function of the glass cover of a greenhouse, hence the term 'greenhouse effect'). These gases are called 'greenhouse gases'. This 'greenhouse effect' maintains the earth's average surface temperature at +15 °C, a condition that supports life forms on the planet, in the absence of which the average temperature would be –18 °C.

Climate models at the global and regional scale (general and regional circulation models) can be used to study and simulate variations in climate because of the human-induced perturbations. The trends in the climate change that have been highlighted in Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) are given below.

- Increase in atmospheric concentrations of CO_2, CH_4, and N_2O by about 31% (±4%), 151% (±25%), and 17%, respectively, between 1750 and 2000 has been reported.
- Increase in mean global surface temperature by 0.6 °C (±0.2 %) over the 20th century has been reported.
- Snow cover has decreased by about 10% since the late 1960s, and sea ice extent during spring and summer has decreased by about 10% - 15% since 1960s. Shifting of alpine plantation and melting of continental glaciers have also been reported.
- Rise in global average sea level between 0.1 m and 0.2 m during the 20th century has been reported.

Since 1850, North America and Europe have contributed to about 70% of CO_2 emissions from energy production while the share of developing countries (non-Annex I nations) has been less than a quarter of the total emissions. However, recent study by Stern (2006) shows that owing to the mounting number of energy-intensive industries and rapid economic growth rates, developing countries will account for more than three-fourth of the rise in fossil fuel emissions by 2030. In the Asia-Pacific region, increased economic development has led to rapid urbanization and industrialization, and the subsequent rise in fossil fuel use has resulted in increasing the region’s contribution to GHG emissions. In 1990, the region produced 435 MT (million tonnes) (8%) more CO_2 than North America. By 2002, the figure rose to 2628 MT (41% more). Focusing only on the total emission levels, however, would only give a myopic view of the GHG emission scenario, as the countries having the largest absolute emissions are not necessarily the ones with largest per capita emissions.

Among the top 25 total GHG emitters, Australia, USA, and Canada are among the top per capita emitters (global rank fourth, sixth, and seventh, respectively). Their per capita emissions are about six times that of China (global rank 99) and about 13 times that of India (global rank 140). There is a strong correlation between emissions per capita and income per capita, with affluent countries having higher emissions per capita because of higher consumption rates and energy-intensive lifestyles. One of the greatest challenges of implementing emission abatement measures is that GHG emissions result from almost every major human activity, with large contributions from electricity and heat, transport, buildings, industry, land-use change, forestry, and agriculture sectors. The future rise in emissions is predicted to be mainly in the electricity and transport sectors, highlighting the importance of suitable technological interventions and appropriate policy changes in these sectors. As per the current scenario as well as future energy projections, coal is leading the energy front in global power generation. In order to reduce the current GHG levels, high emitters would need to curtail their oil dependency and reduce coal use. In this regard, natural gas offers a potential substitute in crucial energy sectors because of its lower carbon content. World energy consumption is projected to increase by 71% from 2003 to 2030 (IEO 2006). It is also estimated that reduction in total GHG emissions to three-fourths of the current levels by 2050 shall entail costs that would be in the range –1.0% to +3.5% of GDP (gross domestic product; with an average estimate of about 1%).

Revisiting the Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC) that highlights ‘stabilization of the GHG concentrations to a level that avoids dangerous interference with the climate system, and within a time frame sufficient to allow ecosystems to adapt to climate change and ensure food production is not threatened and economic development proceeds in a sustainable manner’, brings the fact that the role of GHG mitigation technologies cannot be undermined. Many options can be deployed to realize this objective and reduce GHG emissions, such as carbon sequestration and storage, reduction of non-CO_2 gases in sectors apart from energy, and decarbonization of the energy systems. A study states that technologies to sustain the world’s energy needs over the next 50 years are currently operational in various parts of the world; however, the biggest challenge remains to upscale them and overcome the associated issues and barriers.

Glimpse of Kyoto protocol

The adoption of the UN Framework Convention on Climate Change (UNFCCC) in 1992 was a major step forward in tackling the problem of global warming. Yet as greenhouse gas (GHG) emission levels continued to rise around the world, it became increasingly evident that only a firm and binding commitment by developed countries to reduce emissions could send a signal strong enough to convince businesses, communities and individuals to act on climate change. Member countries of the UNFCCC therefore began negotiations on a Protocol – an international agreement linked to the existing Treaty, but standing on its own. After two and a half years of intense negotiations, the Kyoto Protocol was adopted at the third Conference of the Parties to the UNFCCC (COP 3) in Kyoto, Japan, on 11 December 1997. The Protocol shares the objective and institutions of the Convention. The major distinction between the two, however, is that while the Convention encouraged developed countries to stabilize GHG emissions, the Protocol commits them to do so. The detailed rules for its implementation were adopted at COP 7 in Marrakesh in 2001, and are called the "Marrakesh Accords."

Because it will affect virtually all major sectors of the economy, the Kyoto Protocol is considered to be the most far-reaching agreement on environment and sustainable development ever adopted. However, any treaty not only has to be effective in tackling a complicated worldwide problem, it must also be politically acceptable. Most of the world's countries eventually agreed to the Protocol, but some nations chose not to ratify it. Following ratification by Russia, the Kyoto Protocol entered into force on 16 February 2005.

The Protocol requires developed countries to reduce their GHG emissions below levels specified for each of them in the Treaty. These targets must be met within a five-year time frame between 2008 and 2012, and add up to a total cut in GHG emissions of at least 5% against the baseline of 1990. Review and enforcement of these commitments are carried out by United Nations-based bodies. The Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities." This has two main reasons. Firstly, those countries can more easily pay the cost of cutting emissions. Secondly, developed countries have historically contributed more to the problem by emitting larger amounts of GHGs per person than in developing countries. In order to give Parties a certain degree of flexibility in meeting their emission reduction targets, the Protocol developed three innovative mechanisms - known as Emissions Trading, Joint Implementation and the Clean Development Mechanism (CDM). These so-called ‘market-based mechanisms’ allow developed Parties to earn and trade emissions credits through projects implemented either in other developed countries or in developing countries, which they can use towards meeting their commitments. These mechanisms help identify lowest-cost opportunities for reducing emissions and attract private sector participation in emission reduction efforts. Developing nations benefit in terms of technology transfer and investment brought about through collaboration with industrialized nations under the CDM.

The Kyoto Protocol is generally seen as an important first step towards a truly global emission reduction regime that will stabilize GHG concentrations at a level which will avoid dangerous climate change. As a result of the Protocol, governments have already put, and are continuing to put legislation and policies in place to meet their commitments; a carbon market has been created; and more and more businesses are making the investment decisions needed for a climate-friendly future. The Protocol provides the essential architecture for any new international agreement or set of agreements on climate change. The first commitment period of the Kyoto Protocol expires in 2012. By then, a new international framework needs to have been negotiated and ratified which can deliver the stringent emission reductions the IPCC tells us are needed.

The targets cover emissions of the six main greenhouse gases:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)

The maximum amount of emissions (measured as the equivalent in carbon dioxide) that a Party may emit over the commitment period in order to comply with its emissions target is known as a Party’s assigned amount.

2. Impacts of Climate Change on Different Sectors

There is increasing evidence that climate changes have affected a diverse set of physical and biological systems across the world and in case of inaction, the effects would only multiply manifold. Developing countries, in particular, are more vulnerable to the impacts of climate change owing to the underlying socio-economic conditions: lack of proper financial markets, institutional and legal structures, technological expertise; and inadequate access to information and education for majority of the population. The climate varies naturally as well as in response to human influences and therefore it is only one of the determinants of the impacts. The process of climate change is detectable only over long term and the resultant impacts will be rather slow to emerge. Therefore, monitoring of the performance and analysis of routine measurements aimed at detecting changes in the climate, environment and their impacts on different sectors would need to be done.

Asia has a highly variable climate, and experiences frequent wrath of climatic extremes, the disastrous consequences of which further narrow down the coping capacities of millions of poor in the region, who are already grappling with changes in the economic and social systems. In a country like India, which is closely tied to its natural resource base, climate change poses further stress on various sectors in addition to the existing pressures of high population, urbanization, and economic development. IPCC estimates of monetary damages under conditions of doubling of CO_2 (damages expressed as percentage of GDP) indicate that on an average, the economic losses worldwide would be between 1.5% and 2%. This figure lies between 1% and 2% for the developed countries and between 2% and 9% for the developing countries. Analysis of sector-specific impacts of climate change reveals the overlap of the sensitivities among the sectors and also the variety of implications that rapid change in climate might pose.

Over time, as the climate changes, other changes may also occur that alter the populations vulnerability. Vulnerability to extreme weather events, including floods and storms will depend on where and how residential housing is built. This would involve parallel measurements of population and environmental data. The data needed for measuring the impacts on population and different sectors comprise: climatic variables, population, health and other sectoral variables.

Impacts on water resources

Since water forms a core component of climate, one of the major impacts of climate change would be on the hydrological regime and regional water availability. This would further have implications on freshwater supply, rain-fed agriculture, groundwater resources, forestry, biodiversity, and sea level. Scientists have studied the hydrological consequences of future climate scenarios by considering time series analysis of run-off and meteorological parameters, taking into account the long-term variations and trends, use of general circulation and regional models, and specific hydrological models.

Impacts on agriculture and food security

Despite many technological advances such as better crop varieties and irrigation systems, the role of climatic factors in influencing agricultural productivity remains pivotal. Variations in climatic factors can affect crop yields either directly via changes in temperature, precipitation, or CO_2 concentrations, or indirectly through changes in soil properties and distribution, frequency of infestations by pests and insects, and diseases. In the short term, extreme events are more likely to have an adverse effect on agricultural production; however, gradual changes in temperature and rainfall patterns will impact yields in the long run. Variability in patterns of precipitation has implications for both economic growth of agriculture- based economies and also the food security of the poor.

Impacts on forest ecosystems

Changes in climate could alter the configuration and productivity of the forest ecosystems. Rising temperature, changes in availability of water, and enriched CO2 are expected to bring significant changes in species composition in approximately one-third of the forests worldwide.

Impacts on coastal areas

Accelerated SLR (sea-level rise) is one of the most certain outcomes of climate change along with possible increases in the frequency and intensity of cyclones and storms. Rising sea levels result in inundation of land, salt water ingression, and threaten life, livelihood, and property. The situation in small island states becomes more precarious under such circumstances. Complications arise with the displacement of population, and direct and indirect impacts on freshwater reservoirs, fisheries sector, health, and tourism.

Impacts on human health

The impacts of climate change on health could be direct in the form of increasing mortality from extreme temperature and weather events, and also indirect in the form of changes in ecological and socio-economic systems such as transmission of vector-borne diseases, changes in agricultural productivity, malnutrition etc. Communicable diseases such as malaria have been prevalent over the years and it is becoming harder to control the vector because of development of insecticide-resistant strains. Malaria is currently most endemic in South and South-East Asia, but there are concerns that it may spread due to changing climate, urbanization, irrigation, changing agricultural practices, and deforestation.

Impacts on infrastructure and energy

To meet the increasing demands of economic growth, governments make huge investment in infrastructure development. However, changes in the frequency and intensity of extreme events, temperature, and precipitation patterns endanger the financial investments in infrastructure. Studies indicate that increased temperatures would increase the need for better space cooling, thereby enhancing electricity demand. Also, projected changes in water availability would affect energy consumption in the agricultural, industrial, and commercial sectors. The increase in energy consumption can be due to a need for more space cooling/heating, depending on temperature fluctuations. Variability in precipitation patterns would require more reliance on personal irrigation means and increased groundwater usage. High-energy requirement begins a circuitous path leading to higher energy demand, and hence, higher emission rates.

3. Availability of Official Statistics on Climate Change in India

India, the seventh largest country in the world and the second largest in Asia, has a total geographical area of 329 Mha, of which only 305 Mha is the reporting area (the area as per the land records of villages and towns). The mainland stretches from $8^{o}4'$ N to $37^{o}6'$ N and $68^{o}7'$ E to 97^{o} 25' E. It has a land frontier of 15,200 km and a coastline of 7,516 km. While the global environment waits for the world to reach some form of agreement on climate policy, developing countries such as India are entering a phase of higher economic growth. In India, climate change could represent an additional stress on ecological and socioeconomic systems that are already facing tremendous pressures due to rapid urbanization, industrialization and economic development. With its huge and growing population, a 7500-km long densely populated and low-lying coastline, and an economy that is closely tied to its natural resource base, India is considerably vulnerable to the impacts of climate change.

The various studies conducted in the country have shown that the surface air temperatures in India are going up at the rate of 0.4^{o}C per hundred years, particularly during the post-monsoon and winter season. Using models, they predict that mean winter temperatures will increase by as much as 3.2^{o}C in the 2050s and 4.5^{o}C by 2080s, due to Greenhouse gases. Summer temperatures will increase by 2.2^{o}C in the 2050s and 3.2^{o}C in the 2080s. Extreme temperatures and heat spells have already become common over Northern India, often causing loss of human life. Climate change has had an effect on the monsoons too. India is heavily dependent on the monsoon to meet its agricultural and water needs, and also for protecting and propagating its rich biodiversity. Subtle changes have already been noted in the monsoon rain patterns. Scientists warn that India will experience a decline in summer rainfall by the 2050s. The summer rainfall accounts for almost 70% of the total annual rainfall over India and is crucial to Indian agriculture. Relatively small climatic changes can cause large water resource problems, particularly in arid and semi-arid regions such as northwest India. This will have major impacts on agriculture, drinking water and on generation of hydro-electric power.

Apart from monsoon rains, India uses perennial rivers, which originate and depend on glacial melt-water in the Hindukush and Himalayan ranges. Since the melting season coincides with the summer monsoon season, any intensification of the monsoon is likely to contribute to flood disasters in the Himalayan catchment. Rising temperatures will also contribute to the raising of snowline, reducing the capacity of this natural reservoir, and increasing the risk of flash floods during the wet season. Increased temperatures will impact agricultural production. Higher temperatures reduce the total duration of a crop cycle by inducing early flowering, thus shortening the `grain fill' period. The shorter the crop cycle, the lower will be the yield per unit area. A trend of sea level rise of 1 cm per decade has been recorded along the Indian coast. Sea level rise due to thermal expansion of sea water in the Indian Ocean is expected to be about 25-40 cm by 2050. This could inundate low lying areas, down coastal marshes and wetlands, erode beaches, exacerbate flooding and increase the salinity of rivers, bays and aquifers.

Deltas will be threatened by flooding, erosion and salt intrusion. Loss of coastal mangroves will have an impact on fisheries. In India the major delta area of the Ganga, Brahmaputra and Indus rivers have large populations who depends heavily on river resources for their livelihood and they will be mostly affected by any small changes in water regimes, salt water intrusions and land loss. Increase in temperatures will result in shifts of lower altitude tropical and subtropical forests to higher altitude temperate forest regions, resulting in the extinction of some temperate vegetation types. Decrease in rainfall and the resultant soil moisture stress could result in drier teak dominated forests replacing sal trees in central India. Increased dry spells could also place dry and moist deciduous forests at increased risk from forest fires. Medical Science suggests that the rise in temperature and change in humidity will adversely affect human health in India. Heat stress could result in heat cramps, heat exhaustion, heat stroke, and damage physiological functions, metabolic processes and immune systems. Increased temperatures can increase the range of vector borne diseases such as malaria.

For measuring the impacts of climate change official data on various aspects is available in India. Different Ministries/Organisations/Institutions collect and compile the data relating to different indicators of climate changes. Indian Metrological Departments (IMD) is the nodal agency for cyclone warning and monitoring in India. IMD having a list of all depressions and cyclonic storms formed in Arabian Sea as well as Bay of Bengal for more than 50 years. This data is useful in identifying the areas prone to cyclones, storms, and land slides. The daily report of the data is available in the website of IMD. IMD monitors the data on extreme weather events at 310 weather stations located in different parts of the country. The data is being collected at meteorological sub-division level. IMD also collects and maintains the rainfall data which is published on daily, weekly, seasonal and quarterly basis. IMD also maintains the district wise data on heavy/scanty rain falls which may help in identifying the hazards. As regards tropical depressions, IMD maintains data base in respect of tropical depressions in all the coastal districts.

Centre Pollution Control Board and State Pollution Control Board collects the data on different air pollutants like SO_2, NOx, SPM, RSPM at all the important locations through out the country. It also collects the data on green houses gases (GHG) for a few important locations. Ministry of Home Affairs is monitoring the data on damages due to heavy rains, flood and cyclone during South-West monsoon at State and district level. The month-wise data is also available on their website. Although Geological Survey of India (GSI) is having a wide net-work of field level offices, there is no dedicated network for land slide data collection. Only the incidents reported by the district administration to GSI are studied. With regard to floods, Central Water Commission (CWC) has 147 flood forecasting sites in all the major river basins of the country. There is no format indicting the location of the centre and the district, and the moderate, high and unprecedented flood level for dissemination of flood data at district level. Central Water Commission is also monitoring the water availability in the major reservoirs located in different parts of the country particularly in the summer season. Central Bureau of Health Intelligence publishes the data on health in their publication ‘Health Information of India’ every third year. Integrated Disease Surveillance Project is currently in progress and is expected to be completed by 2009 which would provide the health database. Besides, hospital level data is available on morbidity and mortality.

Department of Agriculture and Cooperation maintains the data on land use as per nine fold classification. It also maintains the data on area sown under different crops for different seasons. The impact of extreme temperature on production and productivity is also monitored by the agriculture department. Till 2002, the Department of Agriculture and Cooperation was entrusted with the responsibility to coordinate relief measures, on behalf of the Central Government, in the event of natural disasters and to also handle the subject of natural disaster management in general. After the transfer of subject matter relating to National Disaster Management to Ministry of Home Affairs, Department of Agriculture and Cooperation does the coordination of relief measures necessitated by drought. It also maintains the data on drought through out the country. There is a list of 183 districts which are covered under the drought prone area programme. Ministry of Agriculture conducts all India Soil and Land Use Survey where data on degraded area across all states and union territories are available. The main reason of land degradation is the soil erosion. India’s economy still depends heavily on agriculture and also large number of people depends upon agriculture. Soil erosion is one of the major outcomes of climate change. The survey covers all the aspects of land use pattern and soil characteristics. In India about 45% of total geographical area is affected by serious soil erosion through ravine and gully, shifting cultivation, cultivated wastelands, sandy areas, deserts and water logging. Soil erosion by rain and river that takes place in hilly areas causes landslides and floods. Wind erosion causes expansion of deserts, dust, storms, whirlwinds and destruction of crops while moving sand covers the land and makes it sterile. Excessive soil erosion with consequent high rate of sedimentation in the reservoirs and decreased fertility has become serious environmental problems with disastrous economic consequences.

Government of India recently formed a separate ministry which is known as the Ministry of Earth Sciences. This ministry is mandated to provide the nation with best possible services in forecasting the monsoons and other weather/climate parameters, ocean state, earthquakes, tsunamis and other phenomena related to earth systems through well integrated programmes. The Ministry also deals with science and technology for exploration and exploitation of ocean resources (living and non-living), and play nodal role for Antarctic/Arctic and Southern Ocean research. The Ministry's mandate is to look after Atmospheric Sciences, Ocean Science & Technology and Seismology in an integrated manner. The Earth Commission, under which the Ministry of Earth Sciences works in Mission Mode based on Commission structure, is responsible for formulating policies, oversee implementation of policies and programs in mission mode, and ensure the necessary interdisciplinary integration.

4. Database on Disaster Statistics: A New Initiative in India

Realizing the need to develop a National Statistical System on hazards and disasters which includes impacts of climate change such as droughts, floods, land slides, extreme variations temperatures etc. in India, the Central Statistical Organisation (CSO) in association with National Institute of Disaster Management (NIDM) has taken an initiative for developing a framework for compilation of hazards and disaster statistics on regular basis and publish it in the form of an annual publication. This will provide data for measuring the impacts of all type of disasters including disasters caused by climate change. In India few scientific organizations like IMD, CWC, GSI are collecting hazard/disaster data. Different organizations use different formats and different geographical levels. India is currently developing a uniform framework for compilation of Hazard and Disaster Statistics to get an overall picture of hazard/disaster profile of States and Districts on annual basis. The District has been selected as primary unit for collection of data. The details of data proposed to be collected under hazard and disaster are as follows:

I Hazard Statistics:-

(a) Rainfall:- District-wise data on heavy and scant rainfall and comparison table with normal rainfall

(b) Tropical Depressions:-District-wise tropical depressions in all coastal districts

(c) Seismic Hazards:- Seismic data of all earthquakes with magnitude of 5 and above for districts in India and neighboring countries

(d) Landslides:- Data on all reported landslides

(e) Floods:- District-wise moderate, high and unprecedented floods, Data on reservoir levels of all major reservoirs in the country

(f) Drought, Hailstorms, Pest Attacks: - District-wise data on drought, hailstorm and pest attacks

(g) Industrial Hazards:- Industrial/chemical accidents

(h) Railway hazards and Accidents:- Data on railway deaths, injuries and damages to railway infrastructure

(i) Aviation Accidents:- Aviation accidents involving deaths, injuries and danger to infrastructure

(j) Health Hazards: Important Public health hazards

II Disaster Statistics will contain three parts: Damage, Relief and Reconstruction

(a) Damage data has been classified into eight categories:

(i) Lives (deaths & injuries)

(ii) Livestock (deaths)

(iii) Agriculture (Sown area affected and production loss)

(iv) Housing (full or partial damage)

(v) Infrastructure (damage to roads, bridges, water supply, sewerage system, irrigation, electric supply, shops/commercial buildings, other utilities)

(vi) Environmental Damage

(vii) Damage at macro-economic level

(viii) Health (occurrence of epidemic due to water borne and vector borne disease)

(b) Relief and Rehabilitation

(i) Gratuitous relief

(ii) Supplementary Nutrition

(iii) Assistance to small and marginal farmers

(iv) Input subsidy to farmers other than small and marginal farmers

(v) Employment Generation

(vi) Assistance to small and marginal farmers/ agricultural labourers

(vii) Assistance to fisherman

(viii) Assistance to Artisans in handicrafts/handloom sectors by way of subsidy for repair/replacement of damaged equipments
(ix) Assistance for repair/restoration of damaged houses
(x) Provision of emergency supply of drinking water in rural and urban areas
(xi) Provision of medicines, disinfectants, insecticides for prevention of outbreak of epidemics
(xii) Medical care of cattle and poultry against epidemics as a sequel to a notified natural calamity
(xiii) Evacuation of people affected/likely to be affected
(xiv) Hiring of boats for carrying immediate relief and saving life
(xv) Provision of temporary accommodation, flood, clothing, medical care etc.
(xvi) Air dropping of essential supplies
(xvii) Repair / restoration of immediate nature of the damaged infrastructure
(xviii) Replacement of damaged medical equipment and lost medicines of government hospitals/ health centres
(xix) Operational cost of relief measure/services
(xx) Cost of clearance of debris
(xxi) Draining off flood water in affected areas
(xxii) Disposal of dead bodies/care cases
(xxiii) Procurement of essential search, rescue and evacuation equipments

(**C**) **Reconstruction**:- Information on reconstruction measures.

The main motivation of this endeavour is to develop a database which can help researchers and policy makers in analyzing different aspects related to hazards and disasters and their effects on human lives. The list is prepared keeping this fact in mind. Although the main emphasis is on capturing all types of disaster and hazards, some of the listed hazards are climate related environmental variables while some of them are outcomes of the climate change. This database captures data for all districts in India which will cover all environmentally different regions. Already in India many ministries/organizations/institutions are regularly collecting data on many climate related environmental variables. This database with the help of the existing dataset on climate change can help researchers to develop different models on impact of climate change on issues like hazards, disasters and the economic and social losses due to the climate change. Since data will be available at district level over periods of time, both cross sectional and time series analysis can be performed using this disaster dataset along with existing data on climate related environmental variables which flows regularly from different ministries/institutions/organizations. The following table gives an idea that most of the data which are proposed to be collected through hazards statistics are either climate related environmental variables or the outcome of climate changes.

Name of indicators/variables	Type
Rainfall, Tropical depression, Aviation accidents, Health hazards	Climate related environmental variables
Seismic hazards, landslides, Floods, Drought, Hailstorms, Pest attacks, Aviation accidents, Health hazards	Outcome of climate changes
Industrial hazards, Railway hazards	Neither climate related environmental variables nor an outcome of climate change

Linking these climate related variables and outcomes of climate changes to the data on damages, one can perform a detailed level analysis at the district level. For a country like India which is widely diversify environmentally, the effect on climate change on economic development, ecosystem and human lives can be analysed for different environmental zones once the detailed level data at district is made available. From the environment perspective, it is more interesting to analyse the data for different environmental zones rather than for different states. This database will help environmentalist along with the policy makers in this regard.

5. Concluding Remarks

Climate is the long-term statistical expression of short-term weather which can be defined qualitatively as 'Expected Weather' or quantitatively by statistical expressions such as central tendencies and variances in key parameters. In developing countries the trade off between economic development and environmental degradation is an issue of great concern. Sustainable development not only looks for the stable economic growth but also it has to ensure the minimum exploitation of environmental resources to attain the desired level of development. India is one of the low per capita greenhouse gas emission countries instead of its rapid growth and huge population. But the effect of global warming in the world has also been felt by India and since large populations of India still depends mainly on agriculture for their sustenance; a change in climate will affect them considerably because the change in climate will have a worse impact on agriculture sector. Government of India is now working steadily towards further reduction of GHGs using renewable energies, modern methods and technologies, publicising the importance of environmental sustainability across all stake holders by running different programmes etc. In India, different Ministries/Organisations/Institutions measures and monitors some indicators of climate changes on fairly regular basis. Central Statistical Organisation in collaboration of National Institute of Disaster Management initiated a joint exercise to develop a Disaster Statistics database. This database will be one which can help researchers and policy makers to assess the impact of climate changes on major or minor disaster because although some of these hazards and disasters are manmade but most of them are due to change of climate over a considerable period of time.

References:

1. Government of India (2007): Compendium of Environment Statistics, Eighth Issue, Central Statistical Organisation

2. Intergovernmental panel on Climate Change (2007): Summary for Policymakers, 9th session of Working Group III of the IPCC, Bangkok, Thailand

3. Ravindranath N.H., Joshi N.V., Sukumar R., and Saxena A. (2006): Impact of climate changes on forests in India, Current Science, Vol. 90, No. 3.

4. SPAN: The Urgency of Climate Change, March-April, 2008

5. The Energy and Resource Institute: TERI Energy Data Directory and Yearbook, 2007-08

Gearing a National Statistical System Towards the Measurement of the Impact of Climate Change: The Case of the Philippines[1]

by

Romulo A. Virola
Estrella V. Domingo
Glenita V. Amoranto
and
Edward P. Lopez-Dee[2]

I. Introduction

Concern for climate change has been gaining greater attention in the political agenda of most countries. Such attention has been carved out from the four assessment reports of the Inter governmental Panel on Climate Change (IPCC), the inter governmental scientific body established in 1988 by the World Meteorological Organization (WMO) and the Untied Nations Environment Programme (UNEP) to provide decision-makers and others interested in climate change with an objective source of information about climate change based on scientific evidence and reflects existing viewpoints within the scientific community.

In its Fourth Assessment Report (AR4)[3], the IPCC concluded the following observed changes in earth's climate:

1. Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level;

2. Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases; and,

3. There is medium confidence that other effects of regional climate change on natural and human environments are emerging, although many are difficult to discern due to adaptation and non-climatic drivers.

Warming of the climate system according to the IPCC report is attributed to the observed increase in anthropogenic greenhouse gas (GHG) concentrations.[4]

---

[1] Paper presented during the Conference on Climate Change and Official Statistics organized by the United Nations Statistics Division in collaboration with Eurostat, the World Bank and Statistics Norway held at the Oslo Military Society, Oslo Norway on April 14 – 16 2008.

[2] Secretary General, Assistant Secretary General, Information Technology Officer II, and Statistical Coordination Officer IV, respectively, of the National Statistical Coordination Board (NSCB) of the Philippines. The NSCB is the highest policymaking and coordinating body on statistical matters in the Philippines.

[3] Intergovernmental Panel on Climate Change, Fourth Assessment Report, Climate Change 2007: Synthesis Report.

[4] IPCC. 2007. Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22.http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf. Date Accessed February 26, 2008.

Scientists have found out that global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004. Furthermore, according to the report, the continued and unabated release of greenhouse gases from human activities at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century. Anthropogenic warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change.

1.1. Global Impacts of Climate Change on Growth and Development

The AR4 reports that the global surface temperature registered an increase of 0.74 degree Celsius (1906 to 2005, a hundred year linear trend). Scientific studies show that human health, ecological systems, and socio-economic sectors (e.g. hydrology and water resources, food and fiber production, coastal systems, human settlements) all of which are vital to sustainable development, are sensitive to changes in climate-including both the magnitude and rate of climate changes- as well as to changes in climate variability.

More specifically, the impacts (an impact describes a specific change in a system caused by its exposure to climate change. Impacts may be judged to be harmful or beneficial[5]) of climate change can be simplified as follows:

- a reduction in crop yields around tropical and sub-tropical regions;
- decreased water availability in areas already short of water;
- an increase in the spread of diseases such as malaria, dengue fever, schistosomiasis, and other viral diseases; and
- increased instances of flooding as intensity of rainfall increases and sea levels increase. But, the positive aspects of a small amount of global warming include:
  - increases in crop yields in some mid-latitude regions with temperature increases up to two to three degrees Celsius;
  - potential increase in timber supplies from managed forests;
  - increased water availability in regions such as southeast Asia; and,
  - reduced winter mortality in high latitude regions.

The consequences of climate change will become disproportionately more damaging with increased warming and will vary regionally but, aggregated and discounted to the present, they are very likely to impose net annual costs, which will increase over time as global temperatures increase.[6]

Moreover, AR4 explicitly stated that the poorest developing countries will be hit earliest and hardest by climate change, even though they have contributed little to

---

[5] Schneider, S.H., S. Semenov, A. Patwardhan, I. Burton, C.H.D. Magadza, M. Oppenheimer, A.B. Pittock, A. Rahman, J.B. Smith, A. Suarez and F. Yamin, 2007: Assessing key vulnerabilities and the risk from climate change. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 779-810. Found at http://www.ipcc.ch. Date accessed March 4, 2008.

[6] IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22. Found at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf. Date Accessed: February 26, 2008

causing the problem. Their low incomes make it difficult to finance adaptation. The international community has an obligation to support them in adapting to climate change. Without such support there is a serious risk that development progress will be undermined.

1.2. Climate Change Impacts in the Philippines

The Philippine archipelago, which has one of the longest coastlines and one of the top mega-diversity countries in the world, will not be spared of the adverse impacts of sea-level rise and extreme climate events that are expected to happen in a warmer world.[7] Jabines and Inventor (2007)[8] considers the Philippines as one of the climate hotspot largely due to its geographical features, low level of economic development and exposure exacerbated by poor access to resources.

In his study, Amadore (2005)[9] summarized the climate change impacts that have occurred in the Philippines as follows:

> *The extreme climate events/variability manifested more frequent occurrence of severe El Niño and La Niña events, as well as, deadly and damaging typhoons and other severe storms, floods, flash floods, landslides, drought, forest fires, etc.* ***These extreme events have one thing in common – persistent torrential rains, causing landslides and flash floods, killing people and destroying properties and the environment along its path.***
>
> *The sharpest fall in agricultural production experienced during strong El Niño events and after the occurrence of severe tropical cyclones. On the other hand, increases in rice and corn productions are attributed to favorable rainfall conditions during La Nina years. The highest typhoon damage was 1.17% of GDP and 4.21% of agriculture.*
>
> *The climate change impacts on coastal zones and marine ecosystems observed in 1998 were massive coral bleaching in various reefs throughout the Philippines caused by the elevated sea temperature during the severe 1997-98 ENSO episode. Severe red tide outbreaks also occurred after the strong El Niño periods*
>
> *In the health sector, many of the biological organisms linked to the spread of infectious diseases are especially influenced by the fluctuations in climate variables. Among other factors, dengue fever and malaria are sensitive to such climate parameters as temperature, relative humidity and rainfall. Other climate-related diseases like cholera have been associated with extremes of precipitation, droughts and floods.*

---

[7] Capili E.B., A.C.S. Ibay and J.R.T. Villarin, 2005. Climate Change Impacts and Adaptation on Philippine Coasts. Proceedings of the International Oceans 2005 Conference. 19-23 September 2005, Washington D.C., USA. Pp. 1-8. Found at: http://info.worldbank.org/etools/docs/library/230308/Session%202/Session%202%20Reading%201.pdf. Date accessed: February 26, 2008.

[8] Jabines, Abigail and Jasper Inventor. 2007. The Philippines: A Climate Hotspot. Climate Change Impacts and the Philippines. Greenpeace Southeast Asia, Climate and Energy Campaign. Found at: http://www.greenpeace.org/raw/content/seasia/en/press/reports/the-philippines-a-climate-hot.pdf. Date accessed: February 26, 2008.

[9] Amadore, Leoncio A. 2005. Crisis or Opportunity, Climate Change Impacts and the Philippines. Greenpeace Southeast Asia. Found at: http://www.greenpeace.org/seasia/en/asia-energy-revolution/climate-change/philippines-climate-impacts. Date accessed: February 26, 2006.

The Philippines ranks fourth in the global Risk Index for 2006[10]. The Germanwatch Global Climate Risk Index (CRI) identifies those countries most affected by extreme weather events in specific time periods, based on four indicators:

- total number of deaths,
- deaths per 100,000 inhabitants,
- absolute losses in million US$ purchasing power parities (PPP) and
- losses per unit GDP in %.

Such are the impacts of climate change in the Philippines. Notwithstanding the fact that the Philippines released only a total equivalent amount of 100,738 ktons of CO_2 into the atmosphere in 1994 and projected to increase by 94% or 195,091 (annual growth rate of 4.8%.) ktons of equivalent CO_2 by 2008.[11] This is due to the combined effects of GHG emissions from the four sources of energy, industry, agriculture, and wastes, and the net uptake (sink) of GHGs from the land use change and forestry (LUCF) sector. In the global context, this national amount is still minimal relative to the GHG emissions of other nations, especially those of developed country parties to the UNFCCC.

The alarming threat of the adverse effects of climate change in people's lives warrants a comprehensive strategic planning on the part of policy and decision makers. But planning can be truly effective only if it is based on high quality statistics. Unfortunately, environmental statistics and in particular, statistics on the climate change and its impacts are generally lacking both in terms of quantity and quality, particularly in developing countries. Part of the reason is that national statistical agencies have not been sufficiently involved in the generation of these statistics, not only because of resource constraints but also because of lack of subject matter expertise.

This paper thus presents the mechanisms and structures available that can strengthen the involvement of the Philippine Statistical System (PSS) in the measurement of the impacts of climate change, with particular attention to the social impacts. At the same time, it discusses the challenges facing the PSS in this direction. It also presents a rough framework on indicators on climate change plus some statistics that are already available, both official and non-official.

2. The Present State of Social, Economic and Environment Statistics in the Philippines

2.1 The Philippine Statistical System (PSS)

2.1.1 Organizational structure

The Philippines is one of many countries with a decentralized statistical system. The PSS consists of statistical organizations at all administrative levels, the personnel therein, and the national statistical program. Specifically, the organizations comprising the system include a policy-making and coordinating body

[10] Harmeling, Sven. 2007. Global Climate Risk Index 2008. Germanwatch, December 2007. Found at: http://www.germanwatch.org/klima/cri.htm. Accessed date: January 15, 2008.
[11] Philippines' Initial National Communication on Climate Change. 1999. Found at http://unfccc.int/resource/docs/natc/phinc1.pdf. Date Accessed: January 15, 2008.

– the National Statistical Coordination Board (NSCB); a single general purpose statistical agency - the National Statistics Office (NSO); a statistical research and training center – the Statistical Research and Training Center (SRTC); and units of government engaged in statistical activities either as their primary function or as part of their administrative or regulatory functions.

The major statistical agencies and all other producers of data are situated in various administrative hierarchies of the country (national, regional, provincial, city, municipal, and barangay levels) with each unit collecting and aggregating data. There are 307 government agencies which may have central and/or local offices located in 17 regions, 81 provinces, 136 cities, 1,494 municipalities, and 41,995 barangays[12] in the country. In addition, the local government units in each province, city, municipality or barangay are rich sources of data. The Local Government Code of 1991 devolved some basic powers and facilities to these local government units which necessarily included data generation.

As the highest policy-making and coordinating body on statistical matters, the NSCB formulates policies, delineates responsibilities, sets priorities and standards on statistics and administers the one-stop statistical information center. The major goal of the NSCB is to promote the independence, objectivity, integrity, relevance and responsiveness of the PSS. The NSCB, as coordinator of the PSS, is not engaged in primary data collection. At the helm of the NSCB is the NSCB Executive Board which is composed of the undersecretaries of the different departments and heads of major statistical agencies and chaired by the Secretary of Socio-Economic Planning.

At the subnational level, the functions of the NSCB are replicated through the NSCB Regional Divisions which perform the mandate of coordination using mechanisms similar to those available at the national level, as well as provide technical assistance to the data producers and users in the regions.

The highly decentralized administrative structure of the country raises complex demands on the statistical system which are difficult to respond to especially under severe resource constraints. Nonetheless, the PSS must exert best efforts to meet the challenge of generating statistics on the social impacts of climate change.

2.1.2 Existing mechanisms in the PSS that would be useful in the generation of official statistics for measuring the social impacts of climate change

The NSCB coordinates the process of data generation and dissemination in the PSS through a number of mechanisms aimed at promoting a more efficient statistical system and ensuring, reliable, relevant and accessible information. These mechanisms can serve as important tools to advocate for the measurement of the impacts of climate change by the PSS.

a. Philippine Statistical Development Program (PSDP)

The PSDP is the blueprint of the integrated vision and priority programs and projects to be undertaken in the PSS for the medium term in order to meet current and emerging needs of the national and local planners, policy-makers and data producers. The formulation of the sectoral statistical development programs is

[12] As of 31 December 2007.

spearheaded by the NSCB through the various inter-agency committees, task forces and working groups composed of the key players and stakeholders in the different sectors and the PSS. Indicative budget requirements for the programs and activities are also included.

The PSDP, which is prepared every six years and updated annually, is designed to provide vital information support to the Medium-Term Philippine Development Program (MTPDP). The current PSDP 2005-2010 is the 7th PSDP formulated by the PSS. This is the Philippine version of the National Strategy for the Development of Statistics (NSDS) being advocated by PARIS21[13] or Partnership in Statistics for Development in the 21st Century.

The PSDP is backed up by the agency's statistical calendars. The statistical calendar contains information on the statistical activities of the agency, such as the frequency, outputs to be generated, expected date and mode of release, and contact person.

The current PSDP 2005-2010 has chapters on sectors that are most likely affected by climate change such as Environment and Natural Resources (ENR), Agriculture and Agrarian Reform, Poverty, Population and Housing, and Health and Nutrition. According to a review made on the 2004-2010 MTPDP to assess whether climate change has been integrated in the national development policies and programs, while no explicit mention of adaptation to climate change was made in the current MTPDP, there is a strong commitment to address the impacts of climate-related hazards. Hence, this would be a good starting point in mainstreaming climate change in the country[14]. Moreover, the current MTDPD is being updated to include programs concerning climate change. Once strategies of sustainable development have integrated environmental and climate change issues into the country's development plans and policies, the PSDP can easily be used as a vehicle to implement statistical programs and policies towards the provision of resultant environmental and socio-economic data.

b. System of Designated Statistics (SDS)

The SDS is a mechanism for the identification and generation of crucial statistics for administrators, planners, policy makers, and decision makers in the government and private sectors. It is also an important tool in addressing problems, such as data gaps, duplication, delayed release and inaccessibility of important sets of statistics, and as a framework for setting priorities in data production.

The designation of statistics includes the implementing agency and prescribed frequency of collection, geographic disaggregation and schedule of data dissemination. The initial set of designated statistics was approved under EO 352 dated July 1996. Subsequent designation or any modification is issued officially through a Resolution from the NSCB Executive Board. Based on these issuances, sixty (60) statistics/statistical activities have been designated under the system. These designated statistics receive priority attention in the preparation of the national budget.

For the ENR sector, there are currently three designated activities, namely: (a) Generation of mineral statistics; (b) Generation of forest resources statistics; and

[13] PARIS 21 is an OECD-based consortium that promotes strategic statistical planning.

[14] Lasco, RD, Pulhin, FP, Jaranilla-Sanchez, PA, Garcia, KB and RV Gerpacio. 2008. Mainstreaming Climate Change in the Philippines. Working Paper nr 62. Los Banos, Philippines. World Agroforestry Centre. 23p.

(c) Generation of land area statistics. The SDS will be a useful tool to ensure the regular and timely generation of statistics and indicators that will be required in measuring the social impacts of climate change. Initially, a core set of environmental indicators may be developed or recommended for designation.

c. Budget Review and Prioritization

One of the functions of the NSCB is to review budgetary proposals for statistical activities of agencies. For many years now, the annual Budget Call issued by the Department of Budget and Management (DBM) provides that the NSCB endorse agency budget proposals involving the SDS.

d. Statistical Survey Review and Clearance System (SSRCS)

The SSRCS involves the substantive review of the design and instruments of statistical surveys or censuses sponsored and/or to be conducted by government agencies, including government corporations at the national and/or subnational level. Recently, the scope of the SSRCS has been expanded to include administrative recording systems. The system aims to ensure the quality of the data to be generated from the inquiry, to avoid unnecessary duplication in data collection and to elicit the cooperation of data providers and respondents.

e. Statistical Standards and Classification Systems

The standard classification systems which are aligned with the international classification systems recommended by the UN Statistical Commission serve as instruments for promoting the comparability and consistency of statistics generated by data producers. They can also be used in the organization of databases and information systems.

Other standards include the prescription of standard concepts and definitions in the various sectors to ensure the comparability of statistics generated.

Existing classification systems include the Philippine Central Product Classification (PCPC), Philippine Standard of Classification of Education (PSCED), Philippine Standard Commodity Classification (PSOC), Philippine Standard Geographic Classification (PSGC), and Philippine Standard Industrial Classification (PSIC) while standard concepts and definitions have been developed for Education, Forestry, Foreign Direct Investments, Health and Nutrition, Housing, Informal Sector, Labor and Employment, Population, Poverty, Prices and Tourism.

Gaps in the availability of data is not the only problems relating social conditions to environmental or climate change variables. Integration of the different data sets available in the PSS useful for the measurement of social impacts of climate change require that primary data sources be comparable, that is, adoption of uniform standard concepts and methods. The PSS can help in this area by prescribing statistical standard and classification system on environment.

f. Technical and Inter-Agency Committees on Statistics (TCs/IACs) and Task Forces (TFs)

The TCs/IACs/TFs are created (1) to assess and evaluate the quality, usefulness and timeliness of sectoral data and determine areas of duplication, discrepancies and gaps; (2) to review the concepts, techniques and methodologies used in the collection, processing and reporting of data; and (3) to recommend an efficient and workable scheme for the allocation of agency responsibilities in the production of statistics. The TCs/IACs/TFs are composed of both data producers and users from government, the private sector and the academic and research communities. To date, the NSCB committees include six TCs, ten IACs and two TFs.

The Interagency Committee on Environment and Natural Resources Statistics (IAC-ENRS) was created on 5 September 2007 thru NSCB Memorandum Order No. 4, Series of 2007 in recognition of the fact that the generation of accurate and reliable ENR statistics and indicators can be best achieved thru the collaborative efforts of concerned agencies. The creation of the IAC-ENRS was one of the priority statistical development programs for the environment and natural resource sector of the 2005-2010 PSDP. The IAC-ENRS was created primarily to serve as a forum for the discussion and resolution of concerns/problems and issues in the compilation of ENR statistics and environmental accounts. The IAC is chaired by the Undersecretary for Policy, Plans and Programs of the Department of Environment and Natural Resources (DENR) and jointly co-chaired by the Director of the Policy and Planning Services of the DENR and the Director of the Economic Statistics Office (ESO) of the NSCB. The members compose of producers and users of environment statistics from government agencies as well as other stakeholders from the academe, non-government organizations and the private sector.

For social-related concerns, existing interagency and technical committees are the TC on Population and Housing Statistics, TC on Poverty Statistics, IAC on Agriculture, Fishery and Forestry Statistics and the IAC on Health and Nutrition Statistics.

Aware that the statistical problem areas and priority setting at the subnational level could be better attended to with the institutionalization of structures for coordinating statistical operations at the subnational level, Regional Statistical Coordination Committees (RSCCs) were established by the NSCB, through NSCB Resolution No. 1, Series of 1992, to provide direction and guidance to statistical development activities in the regions and to analyze, evaluate and recommend improvements on statistics needed in responding to local concerns. The RSCCs serve as the body for policy and issue resolution and statistical coordination at the subnational level. The RSCC in each region is chaired by the Regional Director of the National Economic and Development Authority (NEDA)[15] and co-chaired by the Regional Census Officer of the NSO. Members include Regional Directors of the Department of Budget and Management (DBM), the Department of Interior and Local Government (DILG), and the Department of Labor and Employment (DOLE), the City/Municipal Planning and Development Coordinator in the regional center, and representatives from the Bureau of Agricultural Statistics (BAS), the NSCB, and the private sector. The NSCB Regional Units provide the technical and administrative support functions to the RSCCs.

The Resolution also empowers the RSCC to create inter-agency statistical task forces to resolve technical issues and problems in the region. It also supervises the activities of these task forces.

So far, RSCCs have been established in ten regions where the NSCB has Regional Divisions. Further, in Region XII, Provincial Statistical Coordination

[15] The National Economic and Development Authority (NEDA), as mandated by the Philippine Constitution, is the country's independent economic development and planning agency. It is headed by the President as chairman of the NEDA board, with the Secretary of Socio-Economic Planning, concurrently NEDA Director-General, as vice-chairman. All Cabinet members, as well as the Central Bank Governor, are members of the NEDA Board. The NSCB is one of the attached agencies of NEDA.

Committees (PrSCCs) and City Statistical Coordination Committees (CSCC) were created to serve as the highest policy-making and coordinating bodies on statistical matters at the subregional levels. Region VII will likewise be creating PrSCCs on a staggered basis starting this year.

A total number of 39 statistical TFs, TWGs and technical subcommittees have been created by the various RSCCs since their creation.

g. Development and Maintenance of Statistical Frameworks and Multi-Sectoral Indicator Systems

The NSCB develops and maintains statistical frameworks and indicator systems that involve various sectors and agencies. These indicator systems are used as frameworks for coordination. An example is the Philippine System of National Accounts (PSNA) that produces estimates of the Gross National Product (GNP) and Gross Domestic Product (GDP). The PSNA is maintained by the NSCB with data inputs coming from various agencies including private institutions. Other indicator systems that are maintained by the NSCB include the System of Leading Indicators, Foreign Investments Information System, Gender and Development Indicators, Poverty Statistics, Philippine National Health Accounts, Food Balance Sheet, Quarterly Economic Indices and the STATDEV, which is a tool for monitoring the targets under the Medium-Term Philippine Development Plan and the Millennium Development Goals (MDG). The NSCB also serves as the repository of the MDG database for the Philippines.

The most relevant framework and indicator systems that would be useful for assessing the impact of climate change are the Philippine Framework for the Development of Environment Statistics (PFDES) and the Philippine Economic-Environmental and Natural Resources Accounting (PEENRA).

g.1 PFDES

The Philippine Framework for the Development of Environment Statistics (PFDES)[16], which was based on the UNFDES, is a systematic organization of the interdisciplinary nature of environment statistics and focuses on the identification, description and presentation of data variables which are useful for tracing and verifying interrelationships among human activities and natural events. The PFDES was undertaken to solve the inadequacy in the collection and compilation of environment statistics.

The PFDES relates each component of the environment (Flora, Fauna, Atmosphere, Water, Land and Soil, Mineral and Energy Resources, Flora and Human Settlements) to four information categories, namely: (1) Social and economic activities and natural events; (2) Environmental impacts of activities and events; (3) Responses to environmental impacts; and (4) Stocks and inventories.

Social and economic activities and natural events include human activities and natural events which directly affect the different components of the environment, thus, producing environmental impacts. Environmental impacts of activities and events, as the name suggests, attempts to quantify the negative effects on the environment of man's activities and natural events. Negative impacts are manifested

[16] The PFDES was initiated by the Technical Assistance of the Asian Development Bank (ADB) through RETA 5555 "Institutional Strengthening and Collection of Environment Statistics in Selected Developing Member Countries". Through the project, the compilation of the PFDES was institutionalized at the NSCB.

in the depletion of natural resources (measured in terms of changes in the quantity), environmental degradation (measured in terms of the changes in the quality) and the consequential health and welfare effects. Man's various attempts to curb and mitigate these negative impacts gives rise to the third information category, namely, responses to environmental impacts. These responses can either be defensive/curative such as cleaning up or preventive such as regulating human behavior. Further, responses may be in the form of policies, programs and projects designed to monitor and control pollutants, develop and apply environmentally sound techniques, change the production and consumption patterns, manage and use properly the natural resources, prevent and mitigate the effects of natural disasters and improve the living conditions in human settlements. The fourth category, stocks and inventories, is intended to provide "benchmark" data for possible linkage with other subject areas.

Within each information category are statistical topics which formed the basis in identifying relevant statistical variables to be included in the framework.

Compilation of environment statistics based on the PFDES was institutionalized at the NSCB starting 2000 through the biennial release of the Compendium of Environment Statistics (CPES).

Statistics gathered from the PFDES would be a rich data source for assessing the social impacts of climate change, specifically the component on Environmental Impacts of Activities and Events.

g.2 Philippine Economic-Environmental and Natural Resources Accounting (PEENRA)[17]

The PEENRA is a satellite environmental account of the Philippine System of National Accounts (PSNA) which is being compiled by the NSCB. The PEENRA covered both the physical and monetary estimates for the use of the resources (depletion) as well as the environmental impact of the selected economic activities (degradation). Implementing agencies include the NSCB, DENR and its bureaus and attached agencies, NEDA, NSO, DA and DTI. Publications of environmental accounts covering five resources and fourteen economic activities have so far been released. The compilation of these environmental accounts was made possible through intensive training workshops aimed at developing and enhancing the capabilities of the NSCB Staff and other concerned government agencies. The said accounts were presented on more than one occasion to various stakeholders from the government, private and non-government organizations for comments and suggestions.

In recognition of the usefulness of the PEENRA system in generating macro-indicators that reflect the relationships and interactions between the natural environment and the economy, E.O. 146 was issued on 21 March 1997 *Institutionalizing the PEENRA System and Creating Units Within the Organizational Structure of the DENR, National Economic and Development Authority (NEDA), and NSCB.* Per said E.O., PEENRA Units shall be created within the organizational structure of the NSCB and the DENR while a unit at NEDA shall be designated to coordinate ENRA activities. The NSCB Unit shall mainly be responsible for the compilation of the environmental accounts, and studying and formulating viable

---

[17] This section is an excerpt from the Country Report – Environmental Accounting: The Philippine Experience and Future Plans presented by Estrella V. Domingo during the International Workshop on Environmental and Economic Accounting 18-22 September 2000, Manila, Philippines

approaches and methodologies for the PEENRA while the DENR Unit will be responsible in the compilation of sectoral resource accounts, in studying and formulating viable approaches and methodologies in coordination with the NSCB, and in conducting studies and researches in support of policy development related to PEENRA. Other agencies which will provide inputs to and adopt the PEENRA system are allowed to establish their own PEENRA units as necessary. Further, Section 2 of the E.O. requires that the NSCB designate the required environment and economic statistics while the concerned agencies/bureaus shall be responsible for generating such data. To provide directions for the coordinated functioning of the PEENRA Units, the PEENRA Steering Committee (PEENRA-SC) was created which initially included the NSCB, DENR, NEDA NSO, DTI and DA. Unfortunately, the creation of the NSCB environment unit has not been provided with the required budgetary support.

h. Performance Measurement Scheme for Statistical Agencies and Other Data Producers

A Performance Measurement Scheme for Statistical Agencies and Other Data Producers was institutionalized in 2002. It determines the capabilities of agencies in responding to the needs of their clients and other stakeholders through a set of indicators of agency performance in terms of relevance, timeliness, accuracy, reliability, transparency and integrity, comparability, effectiveness, accessibility and client orientation. Through the scorecard that will be maintained for each agency, the public will be made aware of the success of the agency in accounting for its commitment to the public. Ultimately, the results will be used for advocacy, promoting public accountability and benchmarking purposes as basis for pursuing improvements in the quality of outputs and services.

i. Joint PSS Programs

For concerns affecting all sectors, the NSCB initiates the conceptualization and implementation of PSS-wide programs with the participation of various agencies. Some examples include the **Government Statistics Accessibility Program (GSAP)**, the holding of the **National Statistics Month** in October every year and the triennial **National Convention on Statistics**. The implementation of these programs is led by the NSCB.

The NSM is observed annually during the month of October, as a vehicle for soliciting the support of the public in improving and enhancing the quality and standards of statistics in the country. The NSM, which went on its 18th year in October 2007, has become an effective venue for strengthening and unifying the Philippine statistical community and in instilling nationwide awareness and appreciation of the importance of statistics. Every year, the NSM focuses on a particular theme to highlight the statistics pertaining to the theme. The major activities undertaken by government agencies and some private institutions include symposia and training/seminars/lectures, information dissemination using print and broadcast media and statistical contests. The 1995 celebration of the NSM had the theme - "Statistics Towards Sustainable Development: Focus on Environment" with the Department of Environment and Natural Resources (DENR) as the host agency. In order to raise nationwide awareness on the importance of statistics in measuring the impacts of climate change and the mitigation of its negative outcome, the social impacts of climate change can be made as a theme of the National Statistics Month (NSM) for 2009.

Another venue for statistical advocacy is the National Convention on Statistics (NCS) held every three years to provide a forum for exchanging ideas and experiences in the field of statistics, in both theoretical and practical applications and for discussing recent statistical developments and prevailing issues and problems of the PSS. It further aims to elicit the cooperation and support of statisticians and professionals in related fields, from the government, academe and private sector towards a more responsive statistical system. The highlights of Convention include the presentation of papers on specific topics and holding of commercial exhibits. The 10th NCS held in October 2007 had 2 sessions/topics on Environment and Natural Resources, namely: (a) Use of Statistics in Environmental Concerns in Visayas wherein three papers were presented; and (b) New Approaches in Environment and Natural Resources Statistics in which two papers were presented. The 11th NCS to be held in October 2010 could have sessions specifically on climate change.

j. Users' Forum

The NSCB encourages the active participation of data users from various sectors in different fora to enhance awareness and appreciation of available statistics, to gather feedback towards the improvement of PSS products and services, and to communicate ongoing developments and plans.

2.2 Potential socio-economic impacts of climate change

As mentioned in the early section of the paper, climate change threatens the basic elements of life for people around the world - water, food, health, and use of land and the environment. The following are some of the social impacts of climate changes in Asia and the Philippines as compiled from previous studies and researches.

2.2.1 Agriculture and food security

Because of high temperature, severe drought, flood condition, and soil degradation associated with climate changes, agricultural productivity in Asia is likely to suffer severe losses, thus increasing the risk of hunger and water resource scarcity. Likewise, future changes in ocean currents, sea level, sea-water temperature, salinity, wind speed and direction, strength of upwelling, the mixing layer thickness and predator response to climate change have the potential to substantially alter fish breeding habitats and food supply for fish and ultimately, the abundance of fish populations in Asian waters[18]. In the Philippines, the sharpest fall in gross value added (GVA) and in volume of production in agricultural sector was in 1982-1983 and 1997-1998, the occurrence of the two strongest El Niños in the country. There was a decline in GVA and in volume of production of 4 principal crops (rice, corn, sugarcane and coconut). Increases in GVA in rice and corn production are attributed to favorable rainfall conditions during La Nina years[19].

Food safety is likewise at risk as shown by the following:

---

[18] IPCC, 2001. Climate Change 2001. Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken and K.S. White, Eds., Cambridge University Press, Cambridge, 1032 pp.

[19] Amadore, Leonico A. 2005. Crisis or Opportunity, Climate Change Impacts and the Philippines. Greenpeace Southeast Asia. Found at: http://www.greenpeace.org/seasia/en/asia-energy-revolution/climate-change/philippines-climate-impacts. Date accessed: February 26, 2006.

- Several studies have confirmed and quantified the effects of high temperatures on common forms of food poisoning, such as salmonellosis.[20]

- Contact between food and pest species, especially flies, rodents and cockroaches, is also temperature-sensitive. Fly activity is largely driven by temperature rather than by biotic factors[21]

- Harmful algal blooms (Chapter 1, Section 1.3.4.2) produce toxins that can cause human diseases, mainly via consumption of contaminated shellfish. Warmer seas may thus contribute to increased cases of human shellfish and reeffish poisoning (ciguatera) and poleward expansions of these disease distributions[22]

2.2.2 Human settlements and society

The most widespread direct risk to human settlements from climate change is flooding and landslides, driven by projected increases in rainfall intensity and, in coastal areas, sea-level rise. (IPCC-TAR findings). The Philippines, being an archipelago, has substantial number of families living in coastal areas making them specially susceptible to storm surges brought on by negative environmental factors, such as, the destruction of mangroves, coral reefs, and other forms of natural barriers, siltation of river deltas, bays and gulfs, and shore -line reclamations. The use of non-durable building materials largely account for the huge number of houses being totally or partially destroyed by strong typhoons.[23] Likewise, migration is expected in the coming decades as a consequence of climate-related interference on human populations. "*Circular migration patterns, such as those punctuated by shocks of migrants, following extreme weather events, could be expected. Such changes would likely affect not only internal migration patterns, but also migration movements to other western countries.*"[24]

While the world's poorest, numbering 3 billion around the wo rld, are the least responsible for climate change, they will be hardest hit by climate change as they are more dependent on natural resources and have less of an ability to adapt to a changing climate[25] due to their limited access to information, technology and other capital assets which make them highly vulnerable to climate change. Those at greater risk include, in all countries, the urban poor, the elderly and children,

---

[20] Schmidlhuber, Josef, and Francesco N. Tubiello. 2007. Global Food Security under Climate Change. PNAS _ December 11, 2007. vol. 104, no. 50. Found at: http://www.pnas.org/cgi/content/full/104/50/19703. Date accessed February 26. 2008.

[21] Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007: Human health. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 391-431. Found at http://www.ipcc.ch. Date accessed March 4, 2008.

[22] Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007: Human health. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 391-431. Found at http://www.ipcc.ch. Date accessed March 4, 2008.

[23] Amadore, Leoncio

[24] Cruz, R.V., H. Harasawa, M. Lal, S. Wu, Y. Anokhin, B. Punsalmaa, Y. Honda, M. Jafari, C. Li and N. Huu Ninh, 2007: Asia. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 469-506. Found at http://www.ipcc.ch. Date accessed March 4, 2008.

[25] The Nature Conservancy. Climate Change Impacts: Feeling the Heat. Climate Change and Poverty. Found at: http://www.nature.org/initiatives/climatechange/issues. Accessed Date: February 18, 2008.

traditional societies, subsistence farmers, and coastal populations (high confidence). Poorer communities, particularly slum dwellers, are more likely to live in flood-prone areas.[26]

2.2.3 Human health

Based on the report of the Inter governmental Panel on Climate Change Working Group 2, climate change currently contributes to the global burden of disease and premature deaths. Projected trends in climate-change-related exposures of importance to human health will:

- increase malnutrition and consequent disorders, including those relating to child growth and development (high confidence);
- increase the number of people suffering from death, disease and injury from heat waves, floods, storms, fires and droughts (high confidence);
- continue to change the range of some infectious disease vectors (high confidence);
- have mixed effects on malaria; in some places the geographical range will contract, elsewhere the geographical range will expand and the transmission season may be changed (very high confidence);
- increase the burden of diarrheal diseases (medium confidence);
- increase cardio-respiratory morbidity and mortality associated with ground-level ozone (high confidence);
- increase the number of people at risk of dengue (low confidence);

The above findings point to disease monitoring system as the essential basic data source in measuring the health impacts of climate change. In fact, prevalence and death rates associated with malaria are indicators used to measure progress in attaining Goal 6 of the MDG, namely, to combat HIV/Aids, malaria and other diseases.

2.3 Social statistics and indicators in the PSS that would be useful in the assessment of social impacts of climate change[27]

2.3.1 Agriculture and food security

Due to the potential adverse effects of climate change on crop, livestock and fishery productivity and consequently to food supply, regular monitoring of agricultural production as well as food supply and demand is imperative.

In the Philippines, the Bureau of Agricultural Statistics (BAS) is the major source of agricultural statistics which it collects through its various surveys on crops, livestock, poultry and fishery. For agricultural crops, quarterly estimates are produced on area planted/harvested to palay and corn and corresponding volumes of production, while for livestock, poultry and fishery, quarterly estimates are produced on volume and value of production. Production data for other agricultural crops in terms of volume and value are available through the quarterly monitoring system.

---

[26] (IPCC working group 2, p. 393 - very high confidence)

[27] This section drew largely from the following chapters of the PSDP 2005-2010: (a) Agriculture and Agrarian Reform; (b) Population and Housing; (c) Poverty; (d) Health and Nutrition.

Palay and corn stocks available in households, commercial warehouses and retail/wholesale stores are being reported monthly at the national and regional levels.

The Census of Agriculture and Fisheries (CAF), which is one of the statistical activities covered by the SDS, is conducted by the National Statistics Office (NSO) every ten years with the 2002 census being the latest. Tabulated on a national, regional, provincial and municipal levels are data on characteristics of farms such as number and use of farms classified by use, size, type and tenure of operator; cultivated area by crop planted; farm operators and farm workers and other farm inputs. Other data items relates to equipment, machineries, facilities and other farm tools including data on selected agricultural activities such as bee culture/honey production, mushroom culture, orchid growing for sale and other related activities.

The Sugar Regulatory Administration (SRA) generates monthly data on sugarcane while the Philippine Coconut Authority (PCA) collects data on the number of hectares planted to coconut, planting density and distribution of coconut trees. The Bureau of Fishery and Aquatic Resources (BFAR) generates information on the number of licensed commercial fishing vessels (by type of gear and tonnage class), number of fishermen by fishing ground; area of fishponds in operation, swamp lands available for development; and amount of investment and employment in fishponds. Also available from the agency's annual reports are data on imports and exports of fish and fishery products cleared by BFAR and classified by kind, quantity, value and by country of origin and destination. Local trade reports on gathered fishery products by kind, quantity, and value, source and kind of transport used are also available from the published series.

The NSCB, on the other hand, compiles the Food Balance Sheet (FBS) which provides estimates of the overall food supply situation in the country that is available for consumption of the populace and shows the trends in the levels of the country's food supply and changes in its composition and in the type of food available for consumption which are needed in the formulation of national food production and trade programs to satisfy the dietary and nutritional needs of Filipinos. Important indicators produced are the following: (a) Daily per capita food, calorie, protein and fat supply by food group and commodity per year and per day; (b) Domestic utilization (i.e. feed, seed, processed for food, waste and food) and non-food utilization by food group and commodity; (c) Gross and net domestic supply (by source, i.e. production, change in stocks, imports, and exports) by food group and commodity; and (d) Per capita food intake per day compared with per capita supply.

To rationalize the production of statistics for the agriculture, fishery and forestry sectors in all aspects, including collection, processing, analysis and dissemination, the IAC on Agriculture, Fishery and Forestry Statistics (IAF-AFFS) was created in 1995 though NSCB Memorandum Order No.1-95. The IAC-AFFS is chaired by the Director of the BAS and co-chaired by the Director of the Agricultural Staff of the NEDA. Members include representatives from users and producers of agriculture, fishery and forestry statistics from government agencies. One of the most important functions of the IAC is to serve as a forum for the discussion and resolution of issues concerning the generation and dissemination of agriculture, fishery and forestry statistics.

2.3.2 Human settlements and society

The primary sources of population data are censuses and registration of certain events as collected and compiled by the National Statistics Office (NSO).

Population censuses are conducted every 10 years, the latest was conducted in 2000 while the next one is scheduled in 2010. Mid-decade censuses are conducted every five years, the last one being in 2006. In the absence of actual data during the intercensal years, annual population projections and the implied growth rate are considered estimates of actual population size and growth. The NSO continues to process data on births, deaths and marriages as required by law through the civil registration system.

The Census of Population and Housing (CPH) is still the main source of information for verifying population distribution. The Commission on Filipinos Overseas (CFO), for its part, conducts pre-departure registration for Filipino migrants. The CFO provides information on the number/volume of registered immigrants by country of destination, and by major demographic characteristics. The Bureau of Immigration (BI) supervises aliens' immigration into and emigration from the country, and regularly collects and processes the Arrival/Departure (A/D) Forms accomplished by Filipinos entering and leaving the country. The survey on Overseas Filipinos is a major source of statistics on Filipinos who left the country within the last five years including Overseas Filipino Workers.

Levels and rates of mortality and morbidity, to be discussed in greater detail in the succeeding section, is a function of the DOH and collected through its provincial and regional health offices.

Housing statistics are sourced primarily from the CPH undertaken by the NSO in coordination with various government agencies in the housing sector. The housing module of the CPH provides valuable statistics on the structural characteristics of a housing unit. Meanwhile, other housing agencies like the National Housing Authority (NHA), Government Service Insurance System (GSIS), Social Security System (SSS), Home Development Mutual Fund (HDMF), National Home Mortgage Finance Corporation (NHMFC), Housing and Land Use Regulatory Board (HLURB) and Home Guaranty Corporation (HGC) collect and compile statistics related to housing finance and production as part of their administrative functions.

A major source of information for housing expenditures is the Family Income and Expenditure Survey (FIES) conducted by the NSO every three years. It provides information on the total family expenditures and percentage distribution by major expenditure items that include rental of occupied dwelling unit and house maintenance and minor repair by region, by province, and by urban-rural classification.

The NSCB releases official poverty statistics consisting of the food and poverty thresholds, the subsistence and poverty incidence, the income gap, the poverty gap, and the severity of poverty index. Except for the food and poverty thresholds that are estimated annually, the other official poverty statistics are estimated every three years after the results of the FIES of the NSO have become available. The Annual Poverty Indicators Survey (APIS) is conducted by the NSO in years when the FIES is not conducted and is aimed to supplement current poverty statistics through the use of non-income indicators. This survey provides information on the socio-economic profile of families and other characteristics relating to their living conditions. The Human Development Index (HDI) serves as a measure of how the country has performed, not only in terms of real income growth, but also in terms of: (a) people's ability to lead a long and healthy life; (b) to acquire knowledge and skills; and (c) to have access to the resources needed to afford a decent standard of living. The computation of the HDI was institutionalized at the NSCB in collaboration with the Human Development Network[28] starting with the 1997 series.

A summary list of potential indicators in measuring the impacts of climate change on human settlements and society is laid out in Appendix A. Information on the frequency/periodicity, manner of dissemination and source agency are also provided.

Recognizing the need to coordinate population-related activities and to promote the orderly development and maintenance of a system for population and housing statistics that will provide timely, accurate and useful data for the government and the public, especially for planning and decision-making, the Technical Committee on Population and Housing Statistics (TCPHS) was created in 1988 through NSCB Memorandum Order No. 2-88. The TCPHS is chaired by a Professor Emeritus of the University of the Philippines College of Social Sciences and Philosophy and jointly vice-chaired by the former Deputy Administrator of the NSO and the Director of the UP Population Institute. Members indude experts in the field of population and housing statistics from various government agencies, NGO, private sector and the academe.

Executive Order No. 352 designated the formulation of the poverty estimation methodology to the Technical Working Group on Income Statistics (which became the Technical Working Group on Income and Poverty Statistics (TWG-IPS) under the Interagency Committee on Labor, Income, and Productivity Statistics), and the estimation of poverty statistics to the NSCB. Later, thru NSCB Memorandum Order No. 008, Series of 2003, the TWG-IPS was elevated to a Technical Committee giving rise to the present Technical Committee on Poverty Statistics (TC-PovStat). Among other functions, the TC-PovStat is tasked to review and assess the current issues and problems on the poverty statistics and other related indicators being produced by the PSS and to provide expert advice in the development of an efficient system of poverty estimation, taking into consideration the best practices in the generation of official poverty statistics in different countries. The TC-PovStat has a multi-sectoral representation consisting of noted experts in the area of poverty statistics coming from the academe, producers and users of poverty statistics from both government and non-government organizations. It is chaired by a Research Fellow of the Philippine Institute for Development Studies (PIDS) and jointly co-chaired by the Secretary General of the NSCB and the Administrator of the NSO.

2.3.3 Health statistics

The PSS generates information on status, resources and services for both health and nutrition. However, in the assessment of social impacts of climate change, data on health status would be the most relevant statistics.

The Department of Health (DOH) is the major source of data for the health sector. These statistics are mostly derived from administrative reporting forms regularly furnished by the hospitals, rural health units and other units. Some of the most relevant health statistics (associated with climate change) generated by the DOH are prevalence and death rates associated with malaria, incidence of specific

[28] The Human Development Network Foundation Inc. (HDN) is a non-stock, non-profit organization whose mission is to propagate and mainstream the concept of sustainable human development through research and advocacy. The United Nations Development Programme (UNDP) has been providing financial and technical assistance to the HDN for the preparation of the Philippine Human Development Reports and advocacy activities since 1994.

notifiable diseases, causes of morbidity, which are released regularly on an annual basis. Other morbidity statistics generated by the DOH are listed in Appendix A.

The NSO, on the other hand, produces vital health statistics from its civil registration function as mandated by the Civil Registry Law, such as marriages, births, deaths, infant deaths, foetal deaths, maternal deaths, and mortality by leading causes. Other health statistics produced by the NSO that have not yet been linked directly to climate change are levels and trends of fertility, information on family planning, childhood and adult mortality, maternal and child health, and knowledge and attitudes related to HIV/AIDS and other sexually transmitted infections which they gather from the National Demographic and Health Survey (NDHS).

A list of potential indicators in measuring the health impacts of climate change that are available in the PSS is provided in Appendix A. Information on the frequency/periodicity, manner of dissemination and source agency are also shown.

To strengthen the system of compilation and dissemination of national and local health statistics for purposes of monitoring the state of health of the people and to serve as inputs in the formulation of health programs and policies and its corresponding budget appropriations, the IAC on Health Statistics (IAC-HS) was created in 2002 through NSCB Memorandum Order No. 1-2002. Later in 2007, the IAC-HS was reconstituted and expanded to become the present IAC on Health and Nutrition Statistics (IAC-HNS) through NSCB Memorandum Order No. 2-2007. The IAC-HNS is chaired by the Asst. Secretary of Sectoral Management Coordination Office of the DOH and co-chaired by the Asst. Secretary General of the NSCB. Members include users and producers of health and nutrition statistics from various government agencies, the academe, private sector and non-government organization. The primary function of the IAC-HNS is to formulate and recommend appropriate statistical policies that will improve the system for health and nutrition statistics.

3. Issues/Challenges in the Generation of Data/Indicators in Measuring/Monitoring Climate Change Impacts – Philippine Setting

In general, climate change science and the study of climate change impacts in the Philippines are in its formative years. A plethora of issues and problems provide the challenges in the generation of statistics and indicators on climate change and its impacts.

1.1. *On Framework and Indicator Systems*

- *Need for a Climate Change Framework and Indicator System*

Despite the urgent need for statistics on climate change, its development has not progressed as fast because of the lack of a framework/guide on the collection of data and measurement on climate change. The framework sets the statistics/indictors, definitions, methods and statistical practices and standards as guide in organizing, developing and collecting statistics on climate change. It covers statistics/indicators provided by other disciplines like environmental scientists, meteorologist, biologist, geophysicists, chemists, statisticians, etc., from other government and private organizations.

- *Need to pursue and update Disaster Management Indicator System, PEENRA system, and other existing statistical frameworks relevant to the measurement/monitoring, adaptation and mitigation climate change and its impact*

The Disaster Management Indicator System (DMIS) was crafted to serve as basis in the rehabilitation efforts of the government. The framework identified three phases of a disaster namely: disaster preparedness/mitigation phase, disaster phase, and post disaster phase. With climate change and more specifically the scenarios painted in AR4, the DMIS has to be updated to prepare the Philippines on the possible catastrophic effect, mitigation and adaptation measures on climate change.

Likewise, environmental accounting which measures the emissions of economic activities and the depletion of natural resources has to be aggressively pursued using the updated/revised framework of UNSEEA. Similarly, the other information systems, such as the FHSIS, National Epidemic Sentinel Surveillance System, housing statistics with urban and rural disaggregation has to be updated since these are possible inputs to the indicator system on the impact of climate change.

- *Data Problems*

Data on climate change are few and face a number of challenges – the lack of a statistical framework, the difficulty encountered because it cuts across different sectors and requires different expertise, costly, etc. Climate change data exhibits certain properties that makes it difficult to deal with such as the need to be more specific with regards to location and time of observations, data must typically span longer time intervals for observations. More importantly it requires a set of standards to measure the level of impact, adaptation and mitigation of climate change.

2.2. *On Institutional Coordination, Linkages and Capability Building*

- *Need to Strengthen Institutional Linkages*

Obviously, the present data systems/frameworks are not aimed at climate change but on other concerns such as sustainable development. Initial assessment of data requirements points to a large volume of information coming from administrative data of different government agencies as well as from private organizations. Thus, the PSS has to strengthen institutional linkages to address issues and challenges pertaining to the development of statistics on climate change. Institutional collaborations are also important in the development of a statistical framework for climate change and in addressing problems in data collection.

The Inter-Agency Committee on Environment and Natural Resource Statistics (IAC-ENRS) has to give priority to planning and programming the generation, collection, compilation, reporting and dissemination and utilization of climate change statistics. The IAC-ENRS has to put forward to the NSCB Board the necessary statistical activities on climate change, designation, the researches to be conducted and funds to be allocated.

- *Insufficient coordinating structure at the sub national level for the generation, collection, compilation, reporting, dissemination and utilization of climate change and impact statistics*

Climate change impact statistics cuts across many sectors and sub-sectors. Most importantly, climate change impact differs at various geographical locations. A number of government agencies will be involved in the collection and compilation of data. However, some national agencies do not have sub national offices (regional provincial, or municipal) e.g., PAGASA, NWRB, etc. Lack of coordination among these agencies at the sub-national local level may hinder the collection of climate change impact statistics. To provide guidance, a high power inter agency body consisting of high-level officials has to be established. Such body will be helpful in gearing regional development efforts in the planning and programming of the generation, compilation of climate change statistics in specific geographical areas. Unfortunately, due to budget constraints, the NSCB is not yet present in all regions of the country and has insufficient personnel in regions where it is present to handle all the challenges/coordination at the sub national level.

- *Need to strengthen capability of statistical personnel to undertake and handle statistical researches and other activities related to climate change and its social impact.*

Since climate change and its impact is a relatively new field for statistical agencies and other data producers, there is a need to equip them with the necessary training on climate change impact analysis. The PSS therefore has to formulate a training agenda at the national and sub-national levels related to the topic.

Likewise, statistical agencies and other data producers have to recognize the importance of undertaking researches which would serve as basis for continuously improving climate change and impact statistics in terms of the data being produced, the methodologies and techniques used and dissemination of data.

In this regard, the Philippines looks forward for support from the UN agencies, particularly the Statistical Institute for Asia and the Pacific (SIAP) to enhance the capacity of the PSS to measure the impact of climate change.

- *Need to Create Awareness on Climate Change and its Impacts among Statistical Agencies*

The issue of climate change has not yet sunk deep into the mental framework of statistical agencies. To create awareness, statistical agencies need to understand climate change. This will help statistical agencies and other data producers to identify the relevant data to measure/monitor the change and its impact. It will serve as the springboard in the formulation of a statistical framework and indicator system for climate change impact statistics.

3.3. *Resources (manpower and financial)*

The PSS given its character and coordinative advantage to undertake the generation of climate change statistics lacks the required resources to address the issues and challenges presented on a more permanent basis. With the possible catastrophic effect that climate change can bring, data for this has to be planned and programmed in a more holistic manner. It should not only be responding to donor demands.

A comprehensive study on programs and projects that need funding should be drawn by the national government. Likewise, Regional Development Council and the Regional Statistical Coordination Committees should plan programs and project that is suited to the particularity of the their locale.

And lastly, as the IPCC puts it, the poorest developing countries will be hit earliest and hardest by climate change, even though they have contributed little to causing the problem. Their low incomes make it difficult to finance adaptation. The international community, therefore, has an obligation to support them in adapting to climate change.

4. The Way Forward: Integrating Climate Change and Related Statistics into the Philippine Official Statistics

Climate change is the defining human development issue of our generation.[29] It has started to affect the Philippines and definitely the picture is gloomy. Given the present state of the PSS and the issues/concerns that have to be addressed in measuring/monitoring the impacts of climate change, clearly cut strategies have to be planned and implemented.

4.1. Integration of Climate Change Issues into National and Local Development Plan and Policies

The Philippine government created a Presidential Task Force on Climate Change (PTFCC) on 20 February 2007[30] that seeks to address and mitigate the impacts of climate change in the country. Among the functions of the task force are to undertake/initiate strategic approaches and measures to prevent or reduce GHG emissions in the Philippines; design concrete risk reduction and mitigation measures and adaptations responses, especially short-term vulnerabilities, on sectors and areas where climate change will have the greatest impact; and, cause the integration and mainstreaming of climate risk management into the development policies, plans and programs of government, national and local. It is expected that statistical agencies and other government agencies will be involved in the generation of data pertaining to the work of the task force.

The Philippines is in the process of undertaking an improved national GHG inventory and preparing the country's Second National Communication (for submission to the Conference of the Parties (COP) of the UNFCCC.[31]

The enactment of the bill, An Act Establishing the Framework Program for Climate Change, Creating the Climate Change Commission, Appropriating Funds

[29] **United Nations Development Programme.** 2007. Human Development Report 2007/2008, Fighting Climate Change: Human Solidarity in a Divided World. Palgrave Macmillan, New York.
[30] Thru Administrative Order No. 171 signed by President Gloria M. Arroyo.
[31] Environment and Environmental Bureau. Clean Development Mechanism - Philippines. Country and Convention. Found at: http://www.cdmdna.emb.gov.ph/cdm/public/cdm-country.php?main=about&sub=country. Date Accessed: March 11, 2008.

Therefor, and for Other Purposes or the Climate Change Act[32], filed November 20, 2007 in the Philippine Senate is envisioned to serve as the coup de grace for the integration of climate change issues in the development planning system of the Philippines.

Some of the components of the Framework Program are:

a. Local database development and vulnerability assessment to assist communities to identify, understand, and be prepared for the risks brought about by extreme impacts of climate change;
b. Capacity building for DENR, other national agencies, and their regional counterparts in training communities for community-based vulnerability assessment, data gathering and analysis, planning and decision making; and
c. Training of vulnerable communities in the conduct of vulnerability assessments, data gathering and monitoring, planning and decision making for risk management.

Climate change is a very complex issue. It is multi-disciplinary and inter disciplinary in nature. Policymakers need an objective source of information about the causes of climate change, its potential social, economic and environmental consequences and the adaptation and mitigation options to respond to it. To know the impacts of climate change, a national statistical development cooperation program that will document key data/capacity and deficiencies in the impact of climate change data generation and compilation, both at the local and national levels, as well as the proposed/planned solutions, that can serve as a common reference for planning and coordination of national activities and resource mobilization is needed.

4.2. Development of a Statistical Framework and Indicator System in Measuring/Monitoring Climate Change Impacts

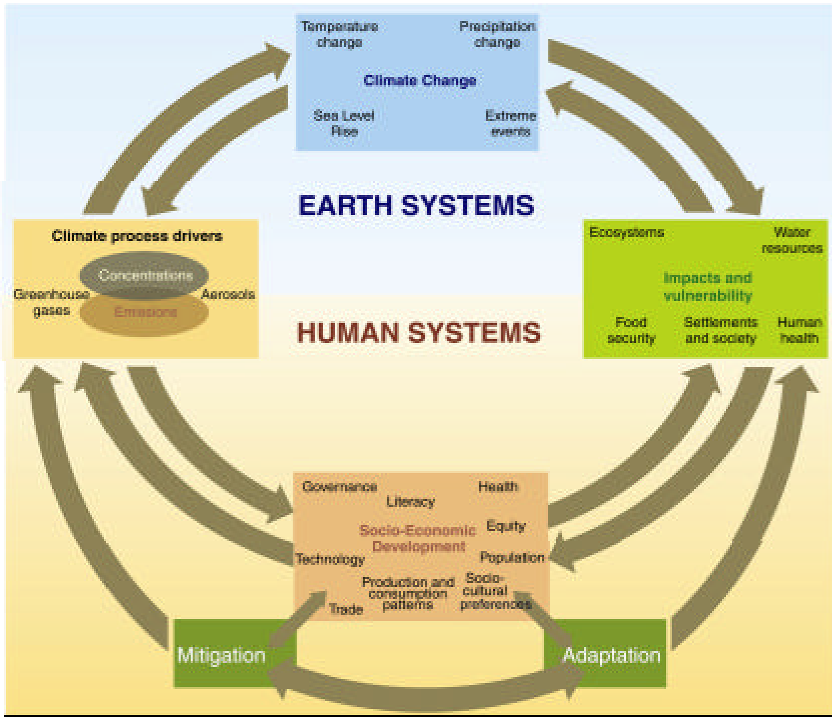
Measuring/monitoring climate change impacts is a gargantuan task. The challenge is to capture the impacts within the timescale of climate change. In order to accomplish this, a statistical framework and indicator system is therefore needed. The framework will provide the set or sets of indicators to be measured in different points. Clearly defined indicators will provide a scale, which can be used to measure the level of impact, adaptation and mitigation of climate change.

AR4 presented a schematic framework representing anthropogenic drivers, impacts of, and responses to climate change and their linkages (see Figure 1). According to AR4, "at the time of the Third Assessment Report (TAR) in 2001, information was mainly available to describe the linkages clockwise, i.e. to derive climatic changes and impacts from socio-economic information and emissions. With increased understanding of these linkages, it is now possible to assess the linkages also counterclockwise, i.e. to evaluate possible development pathways and global emissions constraints that would reduce the risk of future impacts that society may wish to avoid."[33] From the schematic diagram, a conceptual and statistical

---

[32] Senate Bill Number 1890, An Act Establishing the Framework Program for Climate Change, Creating the Climate Change Commission, Appropriating Funds Therefor, and for Other Purposes or The Climate Change Act. Introduced by Senator Loren Legarda, Filed in November 20, 2007, First Regular Session of the Fourteenth Congress of the Philippines.
[33] IPCC, Fourth Assessment Report, Climate Change 2007 Synthesis Report.

framework and indicator system can be developed. A rough draft of a conceptual and statistical framework is presented in Table 1.



Source: Inter governmental Panel on Climate Change, Fourth Assessment Report. Climate Change 2007, Synthesis Report

Figure 1. Schematic Framework representing Anthropogenic drivers, impacts of, and Responses to Climate Change, and their Linkages

The draft of the Philippine statistical framework on climate change provides a systematic organization of the interdisciplinary nature of climate change statistics and focuses on the id entification, description and presentation of data variables which are useful for tracing and verifying interrelationships and interdependency of the earth and human systems.

The draft pictures the changes in the earth system triggered by climate process drivers (concentration of greenhouse gases and the emissions brought about by human activities), the impacts and vulnerability of earth ecosystems and human system due to climate change, and the coping mechanism (mitigation and adaptation) of the human system to climate change. (Table 1)

Changes in the earth system include temperature change, precipitation change, and sea level rise and extreme events.

Climate process drivers include the emissions of industries, agricultural production, energy/electricity production and consumption and waste generation. On the other hand, impacts and vulnerability attempts to quantify the effects (positive and negative) of climate change to the different natural ecosystems, food security/safety, human settlement and huma n health.

TABLE 1. Conceptual Framework On Climate Change Impact

Climate Change	Climate Process Drivers	Impacts and Vulnerability	Socio-Economic Development	
			Mitigation	Adaptation
Temperature Change **Precipitation Change** **Sea Level Rise** **Extreme Events**	**GHG Emissions / Concentration sources** **Industries:** Transport Cement Metal and non-metallic production Chemical and chemical products paper and pulp etc **Agriculture/Forestry** Rice and corn production Agricultural Residue Burning Grassland/Forest burning/fire Agricultural soils **Energy/electricity** Fossil Fuel Production Biomass burned for energy Grassland Burning/Kaingin (slash and Burn)	**Ecosystem (terrestrial and Marine)** Proliferation, depletion and extinction of species Depletion/growth of growth resources Introduction of exotic species Changes of habitat/ecosystem **Water Resources (fresh and Marine water)** Water Depletion Water quality **Food Security/Safety** Food Production (crops and fishery) Occurrence of Harmful Algal Blooms (HABS) Nutritional food Intake Occurrence of crop/fishery disease and infestation	**Health** **Technology** Clean Energy Development Mechanism **Production and Consumption Pattern** **Trade** Carbon trading	**Health** **Technology** Clean Energy Development Mechanism **Production and Consumption Pattern** **Trade** Carbon trading

	Waste Solid wastes Domestics and Commercial Waste Water Industrial Wastewater Hazardous Waste Human Sewage	**Human Health** Occurrence of Vector borne Diseases Occurrence of Skin Diseases Respiratory Diseases Diarrheal Cases **Settlements and Society** Coastal Settlements Settlement in hazardous geologic areas	**Socio-Cultural preferences** **Population** Population in coastal areas (with gender) Population Growth/Density Population control Mechanism **Equity** Poverty Incidence Poverty level **Literacy** **Governance** RURBAN land used Planning Ecological Waste Management Policies Water Resource Management Disaster Management Mechanisms	**Socio-Cultural preferences** **Population** Population in coastal areas (with gender) Population Density/Density Population control Mechanism **Equity** Poverty Incidence Poverty level **Literacy** **Governance** RURBAN land used Planning Ecological Waste Management Policies Water Resource Management Disaster Management Mechanisms

Table 2A. Statistical Framework, Climate Change

Topic	Variables	Measurement
Temperature Change		
	Climatological Normal (temperature mean, maximum and minimum)	°Celcius
	`- national	
	`- regional	
	Temperature, deviation from seasonal mean	°Celcius
	Rate of Change	
Precipitation Change		
	Amount of rainfall	millimeter
	`annual, monthly	
	` national, regional, and provincial	
	Precipitation, deviation from seasonal mean	mm, km^2
Sea Level Rise		
	Sea level increase (normal - high tide and low tide)	meter
	deviation from normal	meter
Extreme Events		
	El Niño and La Niña	number of occurrence
	Typhoon, hurricane, tornado, locaton, population/areas affected	typhoon signals, Quantity
	Floods, flash floods, locaton, population/areas affected	m, h, $km^{2,}$ quantity
	Landslides, locaton, population/areas affected	m, h, km2, quantity
	Tidal Waves, locaton, population/areas affected	km^2, quantity

Table 2B. Statistical Framework, Climate Process Drivers Change

Topic	Variables	Measurement
GHG Emissions / Concentration sources		
Industries:	(can be sourced from environemental accounts)	
Transport	total emissions by type of vehicles	tons/year
Cement	total emissions by type of industry	tons/year
Metal and non-metallic production	toxic air contaminants	tons/year
Chemical and chemical products		
paper and pulp		
etc		
AgricultureForestry		
rice and corn production	Rice and corn production	tons/year
	Area of production (provincial, municipal)	Gg
	Total Ghg emission from rice and corn produciton	hectare
Agricultural Residue Burning	Area burned/kaingin areas	hectare
Grassland Burning	Forest Fires	hectare
Agricultural soils		
Energy/electricty		
Fossil Fuel Production	energy resources production (by sector, by utility)	by capacity (gwh)
	Depletion of energy resources	volume (thousand metric tonnes)
	Energy conversion (by plant, utility)	by capacity (gwh)
Biomass burned for energy	Energy Consumption (by sector, source)	by capacity (gwh)
Waste		
Solid wastes	solid waste disposal/ generation	tons per year, kilogram per capita
Domestics and Commercial Waste Water	toxic waste generated	tons per year, kilogram per capita
Industrial Wastewater	waste disposal in landfill	tons per year, kilogram per capita
Human Sewage	Volume of human sewage	tons per year, kilogram per capita
Hazardous Production	volume of hazardous waste	tons per year, kilogram per capita

Table 2C. Statistical Framework, Climate Change Impact and Vulnerability

Topic	Variables	Measurement
Ecosystem (terrestrial and marine)		
Proliferation, depletion and extinction of species	Number/types of extinct, endangered, vulnerable, etc species	
	Number/types of introduced species	
Depletion/growth of growth resources	Forest area cleared for agricultural production	Hectare
	Area harvested/used in kaingin	Hectare
	Volume of log production	Cubic meter/year
	Area of change	Percent change
	Fish Production (marine, inland municipal and aquaculture)	Tons, kg
Changes of habitat/ecosystem	Mangrove areas converted for aquaculture production	Hectare, km^2, pesos
	Loss of Seagrass Beds	
Water Resources (fresh and Marine water)		
Water Depletion	Amount of surface (by source, rivers, lakes) and groundwater abstraction	Cubic meters per year, liters per second
	Amount of surface (by source, rivers, lakes) and groundwater abstraction for use in irrigation, commercial, domestic and industrial	Cubic meters per year, liters per second
	Average stream flow *(Can be sourced from environmental accounts)*	Cubic meters per second
	Number of sites used for inland, municipal fishery	Number of sites
Water quality	Water quality of receiving water bodies	Concentration (mg/l)
	Number of areas affected by flood	Number, hectares, depth
	Number of rivers, lakes, open waters affected by sedimentation	Number of rivers and lakes affected

Table 2. C. Con't

Food Security/Safety		
Food Production (crops and fishery)	Volume of rice/rice production Volume of fish production (inland, marine and aquaculture	kilograms, tons kilograms, tons
Occurrence of Harmful Algal Blooms (HABS)	Number of occurrence and location	
Nutritional food Intake		calorie
Crop/fishery disease and infestation	Number of occurrence, type of disease and infestation	
Human Health		
Occurrence of Vector borne Diseases	number of occurrence/cases, type, location	
Occuence of Skin Diseases	number of occurrence/cases, type, location	
Respiratory Diseasea	number of occurrence/cases, type, location	
Diarrheal cases	number of occurrence/cases, type, location	
Human Settlements		
Coastal Settlements	Population size, density, dissagregation (male and female)	
Settlement in hazardous geologic areas	Population size, density, dissagregation (male and female), location	

TABLE 2D. Statistical Framework, Socio-Economic Development - Mitigation and Adaptation

Topic	Variables	Measurement
Health		
Technology		
Clean Develoment Mechanis		
Production and Consumption Pattern		
Trade		
Carbon trading		
Socio-Cultural preferences		
Population		
Population in coastal areas (with gender)		
Population Gorwth/Density		
Equity		
Poverty thresholds		
Poverty level		
Literacy		

Man's various attempts to curb and adapt to climate change give rise to the socio-economic development category. This may include technology, health, trade, population, trade, equity, literacy, socio-cultural preferences and governance.

Within each information category are statistical topics which form the basis in identifying relevant statistical variables to be included in the framework.

To operationalize the conceptual framework, the statistical framework for the entire category in the framework will be developed (see Tables 2A to 2D). The statistical framework starts with the topics/items identified in the conceptual framework and proceeds to the identification of specific relevant variables and their corresponding units of measurement needed to quantify the earlier discussed concepts.

The conceptual and statistical framework needs further development as researches on climate change and its impacts become available.

The Indicators system can commence with existing indicators and variables found in the PFDES, asset and emission accounts of SEEA, poverty, health accounts, etc. that are relevant in measuring/monitoring climate change impact, adaptation and mitigation. The IAC-ENRs or PTFCC can organize a task force to study and develop the framework.

4.3. Designation of Climate Change Statistics

With the urgency of the need to formulate plans and programs to mitigate and adapt to climate change, the list of designated statistics has to be reviewed for inclusion of climate change statistics/indicators.

Immediately, the current designated statistical activities, i.e., Energy and Water, Land Area Statistics, Field Health Service Information System (FHSIS) etc, have to be updated to include salient or important climate change impact statistics. It is high time to expand the designated statistics on environment and natural resource statistics. The statistical framework and indicator system to measure and monitor climate change and its impacts that will be developed can guide the IAC-ENR and the NSCB Executive Board on what statistics should be designated.

4.4. ***Standards and Classification System***

The standardization of concepts and definitions is a basic requirement towards generation and improvement of quality climate change statistics. There are various Philippine environmental laws, e.g. Clean Air Act, Ecological Waste Management Act, etc., that contain definitions of terms used for the purpose of the laws. The IAC-ENRS can select the terms which have statistical bearing and recommend these to the NSCB Executive Board for adoption as official climate change/environment and natural resources terms to be used for statistical purposes.

As data generation and research on climate change progress, the PSS thru the NSCB executive Board can lay down the standard methodologies and techniques in data collection, processing and presentation to ensure comparability of statistics produced by the government.

4.5. Partnership Among Government Agencies, Academe and Research Institutions for Continuous Improvement of Climate Change Statistics

According to Zwiers, et. al. (2004)[34], "statistical concepts and methods are necessary in all facets of climate science. Statistical analysis is needed to interpret observations, from either the real world or the artificial world of climate model, in a proper framework. Statistical methods allow one to deal explicitly with the effects of uncertainty on inferences and to quantify its effects on forecasts, projections, etc."

Zwiers, et al have the impression that the discussion about statistical methodology in the climate sciences is generally not very deep and that straightforward craftsmanship is pursued in many cases. As a consequence, much of the statistical practice in climate science is of a homegrown nature. It is often *ad hoc*, and is sometimes not well informed or supported by statistical theory. Moreover, Zwiers, et al suggests that the link between climate and the statistical sciences should continue to be improved with additional efforts such as the Geophysical Statistics. Better communication between statisticians and climatologists requires a better understanding by statisticians of the specifics of climate science, and a greater effort by climatologists to communicate the specifics of open problems to statisticians.

The suggestion of Zwiers, et al. was supported by the American Statistical Association[35] which strongly urges statisticians to collaborate with other scientists in order to advance their understanding of the nature, causes, and impacts of climate change.

The base for future climate change studies is designing future social development scenarios by various models and projecting future regional and local change in climate and its variability, based on those social development scenarios so that the most plausible impacts of climate change could be assessed.

The inaccurate description on future scenario of socio-economic change, environmental change, land-use change and technological advancement and its impacts will lead to incorrect GHG emissions scenarios. These factors affecting design of social development scenarios need to be more carefully examined to identify and properly respond to key uncertainties.

The design of social development scenarios needs intensive research. The Philippine government can gear its science and technology research towards climate science and climate change impact. Different government agencies, national and local, should also involve the research institutions and the academe in any endeavor related to plans and programs.

Capili et. al[36] recommends "that research institutions and the academe in coordination with statistical agencies may provide technical assistance to the implementors by gathering baseline information and monitoring changes, give

---

[34] **Zwiers,** F. W. and Hans Von Storch. 2004. On the Role of Statistics in Climate Research. International Journal of Climatology. Found at: http://geography.uoregon.edu/amarcus/geog620/Guest-Readings/zwiers-IntJClim-2004.pdf. Date Accessed: January 18, 2008.

[35] **American Statistical Association,** 2007. ASA's Statement On Climate Change. Found at: http://www.amstat.org/news/index.cfm?fuseaction=climatechange. Accessed date: January 17, 2008.

[36] **Capili** E.B., A.C.S. Ibay and J.R.T. Villarin, 2005. Climate Change Impacts and Adaptation on Philippine Coasts. Proceedings of the International Oceans 2005 Conference. 19-23 September 2005, Washington D.C., USA. Pp. 1-8. Found at: http://info.worldbank.org/etools/docs/library/230308/Session%202/Session%202%20Reading%201.pdf. Date accessed: February 26, 2008.

recommendations based on scientific findings, and assist in providing technical expertise for capacity building. They may be the ones to provide timely information and current useful and relevant scientific findings for decision-makers and the public. These can be done by conducting studies that include patterns, projections and consequences of both climate variability and change. Generation of localized models for predicting local/regional climate considering topography, land-use patterns, and the surface hydrologic cycle is deemed important a s basis for decision-making."

4.6. Research and Training

The Statistical Research and Training Center (SRTC) can develop a comprehensive and integrated research and training program on theories, concepts and methodologies in climate change and its impact. An effective strategy for advancing the understanding of adverse impacts of climate change will require strengthening the academe and research institutions to conduct innovative research on the response of human and natural systems to multiple stresses at various levels and scales. Key specific research related priorities might deal on the following:

- Enhancing capability to establish and maintain observation facilities and to collect, and compile, climatic, social and biophysical data;
- Measuring impacts of extreme weather events such as disasters from flood, storm surges, sea-level rise, human diseases, plant diseases and insect pests;
- Identification of social vulnerability to multiple stressors due to climate change and environmental change;
- Adaptation researches concerning agro-technology, water resources management, integrated coastal zone management; pathology and diseases monitoring and control and, adaptation and vulnerability in policy formulation; and,
- Identification of the critical climate thresholds for various regions, provinces, municipalities and sectors.

More so in the conduct of these researches, the increased participation of statisticians and the academic community in the conduct of climate change studies continues to offer many statistical challenges that are currently not being tackled and many opportunities for collaboration with geoscientists. Statisticians can advise on how best to *combine data from different sources, how to identify and adjust for biases in different measurement systems, and how to deal with changes in the spatial and temporal coverage of measurements*. The climate science community often requires regular fields of geophysical variables, such as surface temperature, which must be derived from irregular and heterogeneous observations. Evaluating the advantages and disadvantages of different interpolation approaches (referred to as infilling in climate applications) could be very helpful. This research area contains many opportunities for the development and fitting of sophisticated *space-time models to sparse data.*

APPENDIX A

POTENTIAL KEY INDICATORS FOR MEASURING SOCIAL IMPACTS OF CLIMATE CHANGE

Indicator	Manner of Data Dissemination	Frequency	Data Source/Agency
AGRICULTURE AND FOOD SECURITY			
1. Supply and demand of agricultural commodities	Publication, website, press release	Annual	NSCB (FBS)
2. Food sufficiency ratio by type of food commodity			
3. Area planted/area harvested to palay, corn and other crops	Publication, website	Quarterly, Annual	BAS
4. Productivity (e.g., yield per hectare) - Palay, Corn, etc.			
5. Livestock and Poultry Volume of Production and Growth Rates			
6. Fishery Value of Production and Growth Rates			
HUMAN SETTLEMENTS AND SOCIETY			
7. Population count	Web release, Publication, CDs, Public Use Files Web release, Publication, CDs, Public Use Files	Every census year	NSO (CPH)
8. Age and sex structure			
9. Population density			
10. Population in urban and rural areas			
11. Population growth rate by province 12. Rates of in- and out-migration 13. Net migration rate 14. Origin-destination matrix by province			NSO (NDHS) NSO (Survey of Overseas Filipinos)
15. Rates of emigration and immigration			Special Subject Survey on Migration
16. Net international migration			
17. No of overseas Filipinos			Migration Information Centers in the LGUs
18. Countries of origin and destination			
19. Proportion of families with housing units made of strong materials	Publication/Website	Every three years	NSO - FIES
	Publication/Website	Every non-FIES year	NSO - APIS
	Publication/Website	Every 10 or 5 years	NSO – CPH

APPENDIX A con't…..

Indicator	Manner of Data Dissemination	Frequency	Data Source/Agency
20. Proportion of households living in makeshift housing	Publication/Website	Every three years	NSO - FIES
		Every non-FIES year	NSO - APIS
		Every 10 or 5 years	NSO - CPH
21. Proportion of families/households with access to safe water supply		Every three years	NSO - FIES
		Every non-FIES year	NSO - APIS
		Every 10 or 5 years	NSO - CPH
22. Proportion of families with access to sanitary toilet facilities		Every three years	NSO - FIES
		Every non-FIES year	NSO - APIS
		Every 10 or 5 years	NSO - CPH
23. Subsistence incidence		Every 3 years	NSCB
24. Poverty incidence			NSCB
25. Human development index (HDI)			NSCB/HDN
HEALTH			
26. Life expectancy	Publication	Annual	NSO
27. Crude death rate			
28. Infant mortality rate	Web release, Publication, CD, Diskette	Every 5 years	NDHS, NSO
29. Child mortality rate			
30. Under-five mortality rate			
31. Maternal mortality ratio	Publication	Varying	NDHS, NSO
32. Incidence of specific notifiable diseases		Annual	DOH
33. Causes of morbidity			
34. Prevalence and death rates associated with malaria			
35. Prevalence and death rates associated with tuberculosis			

REFERENCES

1. **Administrative Order No. 171**. Creating the Presidential Task Force on Climate Change. Found at: http://www.gov.ph. Accessed date: January 18, 2008.

2. **Amadore**, Leonie A. 2005. Crisis or Opportunity, Climate Change Impacts and the Philippines. Greenpeace Southeast Asia. Found at: http://www.greenpeace.org/seasia/en/asia-energy-revolution/climate-change/philippines-climate-impacts. Date accessed: February 26, 2006.

3. **American Statistical Association,** 2007. ASA's Statement On Climate Change. Found at: http://www.amstat.org/news/index.cfm?fuseaction=climatechange. Date Accessed: January 17, 2008.

4. **CAB T.P. No. 2001-7** (2001): Documentation and Analysis of Impacts of and Responses to Extreme Climate Events – AGRICULTURE SECTOR, Climatology and Agrometeorology Branch (CAB), PAGASA, Quezon City

5. **Capili,** E.B., A.C.S. Ibay and J.R.T. Villarin, 2005. Climate Change Impacts and Adaptation on Philippine Coasts. Proceedings of the International Oceans 2005 Conference. 19-23 September 2005, Washington D.C., USA. pp. 1-8. Found at: http://info.worldbank.org/etools/docs/library/230308/Session%202/Session%202%20Reading%201.pdf. Date accessed: February 26, 2008.

6. **Confalonieri,** U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007: Human health. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 391-431. Found at http://www.ipcc.ch. Date accessed March 4, 2008.

7. **Cruz,** R.V., H. Harasawa, M. Lal, S. Wu, Y. Anokhin, B. Punsalmaa, Y. Honda, M. Jafari, C. Li and N. Huu Ninh, 2007: Asia. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 469-506. Found at http://www.ipcc.ch. Date accessed March 4, 2008.

8. **Domingo, E. V.** Country Report – Environmental Accounting: The Philippine Experience and Future Plans. *Paper presented during the International Workshop on Environmental and Economic Accounting*. 18-22 September 2000, Manila, Philippines.

9. **Environment and Environmental Bureau**. Clean Development Mechanism - Philippines. Country and Convention. Found at: http://www.cdmdna.emb.gov.ph/cdm/public/cdm-country.php?main=about&sub=country. Date accessed: March 11, 2008.

10. **Harmeling,** Sven. 2007. Global Climate Risk Index 2008. Germanwatch, December 2007. Found at: http://www.germanwatch.org/klima/cri.htm. Accessed date: January 15, 2008.

11. **Intergovernmental Panel on Climate Change**. Edited Watson R. T., M. C. Zinyowera, R. H. Moss and D. J. Dokken. 1997. IPCC special Report on the Regional Impacts of Climate Change. Found at: http://www.grida.org.no. Accessed date January 15, 2008.

12. **Intergovernmental Panel on Climate Change**. 2001. Climate Change 2001. Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken and K.S. White, Eds., Cambridge University Press, Cambridge, 1032 pp.

13. **Intergovernmental Panel on Climate Change**. 2007. Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22.http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf. Date Accessed February 26, 2008.

14. **Jabines**, Abigail and Jasper Inventor. 2007. The Philippines: A Climate Hotspot. Climate Change Impacts and the Philippines. Greenpeace Southeast Asia, Climate and Energy Campaign. Found at: http://www.greenpeace.org/raw/content/seasia/en/press/reports/the-philippines-a-climate-hot.pdf. Date accessed: February 26, 2008.

15. **Klein,** R.J.T., S. Huq, F. Denton, T.E. Downing, R.G. Richels, J.B. Robinson, F.L. Toth, 2007: Inter-relationships between Adaptation and Mitigation. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds. Cambridge University Press, Cambridge, UK, 745-777. Found at http://www.ipcc.ch. Date accessed March 4, 2008.

16. **Lansigan**, Felino P. and Arnold R. Salvacion. 2007. Assessing The Effect Of Climate Change On Rice And Corn Yields In Selected Provinces In The Philippines. A paper presented in 10th National Convention on Statistics (NCS) EDSA Shangri-La Hotel. October 1-2, 2007.

17. **The Nature Conservancy**. Climate Change Impacts: Feeling the Heat. Climate Change and Poverty. Found at: http://www.nature.org/initiatives/climatechange/issues. Accessed Date: February 18, 2008.

18. **The Philippine Statistical Development Program (PSDP) 2005-2010**. October 2006. Published by the National Statistical Coordination Board (NSCB), Makati City, Philippines.

19. **Rosenzweig,** Cynthia and Daniel Hillel. 1995. Potential Impacts of Climate Change on Agriculture and Food Supply. Consequences, vol. 1, no. 2. Summer 1995. Found at:

http://www.gcrio.org/CONSEQUENCES/summer95/agriculture.html. Accessed Date: January 15, 2008.

20. **Schmidlhuber,** Josef, and Francesco N. Tubiello. 2007. Global Food Security under Climate Change. PNAS _ **December 11, 2007.** vol. 104, no. 50. Found at: http://www.pnas.org/cgi/content/full/104/50/19703. Date accessed February 26. 2008.

21. **Smith,** Richard L..2007. The Role of Statistician in Public Policy Debates over Climate Change. American Statistical Association Newsletter, Section on Statistics and the Environment. Found at: http://www.amstat_online.org. Date accessed: January 18, 2008.

22. **Schneider,** S.H., S. Semenov, A. Patwardhan, I. Burton, C.H.D. Magadza, M. Oppenheimer, A.B. Pittock, A. Rahman, J.B. Smith, A. Suarez and F. Yamin, 2007: Assessing key vulnerabilities and the risk from climate change. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 779-810. Found at http://www.ipcc.ch. Date accessed: March 4, 2008.

23. **United Nations Development Programme.** 2007. Human Development Report 2007/2008, Fighting Climate Change: Human Solidarity in a Divided World. Palgrave Macmillan, New York.

24. **Villarin,** J.T., G. T. Narisma, M.S. Reyes, S. M. Macatangay, and M. T. Ang. 1999. Tracking Greenhouse Gases. Manila Observatory, Philippines.

25. **Virola**, R.A. 2002. Statistical Challenges on Poverty Reduction in the Philippines. *Paper prepared for the Regional Seminar for Asian Managers on Monitoring and Evaluation of Poverty Reduction Programs, sponsored by the World Bank Institute (WBI) on 9-11 October 2002, Bangkok, Thailand*.

26. **Virola**, R.A. 2007. Challenges and Opportunities in the Coordination of a Decentralized Statistical System. *Paper presented during the Panel Discussion on Prospects and Risks in the Future: How to Manage Uncertainties of the Seminar on the Evolution of National Statistical Systems organized by the United Nations Statistics Division in celebration of the 60th Anniversary of the United Nations Statistical Commission held on 23 February 2007 in New York, USA.*

27. **Wojick,** D. E. 2002. The UN IPCC's Artful Bias on Climate Change. Nexus Magazin, vol. 9, no. 6. Found at: http://www.nexusmagazine.com/articles/climate.html. Accessed date: January 17, 2008.

28. **Zwiers,** F. W. and Hans Von Storch. On the Role of Statistics in Climate Research. International Journal of Climatology. Found at: http://geography.uoregon.edu/amarcus/geog620/Guest-Readings/zwiers-IntJClim-2004.pdf. Date Accessed: January 18, 2008.

Session 4 : Conference papers

Statistical office support for emission trading schemes

Developments in Australia

Peter Harper
Deputy Australian Statistician
Population, Labour, Industry and Environment Statistics
Australian Bureau of Statistics

peter.harper@abs.gov.au

Abstract

The Australian Government is establishing an emissions trading scheme. The design is scheduled to be completed by the end of 2008, with the scheme expected to start in 2010. This paper explores how official statistics can be used to support emissions trading schemes, both in design and implementation. In Australia's case, a key role for official statistics is to provide Input-Output tables of improved quality and timeliness to support the economic modelling underlying the scheme. Emissions trading schemes also provide opportunities for new types of statistics and they have implications for the measurement of economic activity in particular sectors and for the nation as a whole.

Statistical office support for emission trading schemes

Developments in Australia

Background

The Australian Government is establishing a national emissions trading scheme (ETS) as part of an effective framework for meeting the climate change challenge. The scheme will commence in 2010 and work has commenced on the design of the scheme. A 'green paper' canvassing options and preferred approaches on issues, such as which industry sectors will be covered and how emission caps will be set, is scheduled for release in July 2008. The paper will also include ways to address the impacts of emissions trading on Australian households, emissions-intensive trade-exposed industries and other strongly affected sectors. Following the release of the paper there will be public consultation leading up to the development of draft legislation by the end of 2008. During the early part of 2009 there will be a further phase of consultation on the draft legislation. A Bill is expected to be introduced in Parliament in March 2009, and enacted by mid 2009. During 2009 there will also be a round of consultation on the regulations that will underpin the scheme.

The Government has outlined five tests for its ETS:

- An effective ETS must be a cap and trade scheme and include all major emitters
- An effective ETS must effectively reduce emissions. The Australian Government has set a target of a reduction in emissions of 60 percent by 2050
- An effective ETS must be economically responsible. It must provide the right incentives to drive investment in low emission technologies and renewable energy. It is also vitally important that a domestic scheme does not undermine Australia's competitiveness and provides mechanisms to ensure that Australian operations of energy-intensive trade exposed firms are not disadvantaged
- An effective ETS must be fair, with both costs and benefits shared across the community
- An effective ETS must recognise the need to act now, hence the relatively short time-frame for establishing the scheme.

The Australian Government's Department of Climate Change (DCC) is responsible for designing the ETS. The design work builds upon the work of a 2007 Prime Ministerial Task Group on Emissions Trading. It is also drawing on the work of the 'Garnaut Review'. This Review, which is headed by Professor Ross Garnaut, is a joint Federal and State Government study to examine the impacts of climate change on the Australian economy, and to recommend medium to long-term policies and policy frameworks to improve the prospects for sustainable prosperity. The DCC is also being supported by the Australian Treasury in the economic modelling work underpinning the design of the ETS.

The ETS, in both its design and implementation phases, has significant implications for official statistics. In recognition of this, there has been an active dialogue between the Australian Bureau of Statistics (ABS) and the DCC, and other key stakeholders such as Treasury and the Garnaut Review, on statistical issues associated with the

ETS. This dialogue is occurring at both the operational and senior management levels. ABS support has been actively sought (and willingly provided) and the ABS has been provided with additional funding for some of the statistical work to support the ETS.

The statistical implications of the ETS include:

- statistical support for the design and implementation of the ETS, particularly with regard to the assessing the 'economically responsible' and 'fairness' elements of the scheme
- statistical support for examining the impacts of climate change generally
- the need to ensure that new economic activity caused by the ETS is properly measured in official statistics
- the need to ensure that the economic, social and environmental impacts of the ETS are properly captured in official statistics, particularly in order for policy issues arising from these impacts to be addressed.

Each of these implications is explored further below.

Statistical support for the design and implementation of the ETS

The ABS has been funded to support Treasury in their role of providing economic modelling for the establishment and ongoing monitoring of the ETS. The ETS is expected to alter the structure of the Australian economy and to produce 'winners' and 'losers'. The modelling will inform these distributional impacts and assist in the design of compensation schemes, particularly for low income households and energy-intensive trade-exposed industries, which are viewed as two groups likely to be significantly adversely affected by the ETS.

The economic modelling is being undertaken using computable general equilibrium (CGE) models, which are a class of economic model that use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors. A particular feature of CGE models is that they are based on Input-Output (I-O) tables.

In Australia, I-O tables have typically been compiled by the ABS every three to four years[1] and these have generally been released some three to four years after the reference period. Most recently, the 2001-02 I-O tables were released in July 2006. However, in order to support the ETS economic modelling, more frequent and higher quality I-O tables are required. As a result, the ABS has been provided with additional funding to:

- compile the I-O tables on an annual basis
- reduce the period between the reference period and release data
- improve the quality of the data feeding into the I-O tables, and therefore improve the quality of the I-O tables themselves

[1] Annual Supply-Use tables, which are related to I-O tables, are produced to benchmark the national accounts, but these lack the depth of I-O tables for detailed structural analysis.

- improve the integration between I-O tables and other data sets relevant to the ETS design

This work has involved the ABS in early stages of policy development, but it is also a test of the organisation's responsiveness. Funding was only approved in December 2007, and the organisation has had to quickly staff up to handle the work. The first deliverables, which are classification concordances between the I-O tables and the consumer price index and household expenditure survey have already been provided to Treasury. These concordances support the modelling of the impacts of 'carbon prices' on consumer prices and on household (at population sub-group level) budgets. The ABS has also provided advice to Treasury on concordances between quantitative measures of greenhouse gas emissions and I-O industry groups.

The next key milestone will be to publish I-O tables for the 2004-05 reference year, which are scheduled to be released in June 2008. After this, the ABS will move towards the annual production of the tables and engage in a quality improvement program. A key component of this will be increasing, on a 'rolling basis' the range of I-O related information collected in the ABS's Annual Integrated Collection, which is the ABS's main economic collection from businesses across all industries.

A key challenge will be to ensure the relevance of I-O tables in their use as an information base for supporting climate change issues. For example, the energy intensiveness of industries becomes a much more important factor than it has been in the past and this has implications for the collection of data, the compilation of the tables and the dissemination of outputs. The ABS has previously released an environment account, the Energy and Greenhouse Gas Emissions Accounts 1992-93 to 1997-98 'energy account', which combines physical energy quantities with monetary I-O accounts, but this was some years ago before an ETS was 'on the radar'. This account attracted relatively little user interest at the time, but it is expected that statistics of that integrate the environment and economy will become much more important, and with much higher expectations around the quality of these statistics.

Statistical support for examining the impacts of climate change generally

As mentioned above, the objective of the Garnaut Review is to examine the impacts of climate change on the Australian economy, and to recommend medium to long-term policies and policy frameworks to improve the prospects for sustainable prosperity.

This work by the Garnaut Review is particularly relevant to the design of the ETS, as it is necessary in order to establish the emissions 'trajectory' that will underpin the scheme. A range of statistical information is required to support the analysis. While the ABS will not specifically introduce new collections to support the information requirements – partly because the time frames involved are too short – there has been discussions between the ABS and the Review Team on the availability of relevant statistics and how they might be appropriately used. It is possible that this could lead to the secondment of an ABS staff member to the Review Team for a period of time.

More generally, the ABS produces a range of economic, social and environmental statistics that support the analysis of the impacts of climate change, the adaptations required and the impacts of mitigation. Notable examples include the water accounts, statistics on natural resource management, statistics on agricultural practices, and statistics on household environmental behaviours.

Capturing new economic activity in official statistics

The basis of the Australian ETS will be tradeable permits that enable the holder to emit a certain quantity of greenhouse gas, translated into carbon dioxide equivalent. Most, if not all, of these permits are likely to be allocated by way of some form of auction mechanism, which is expected to generate significant amounts of revenue for the Australian Government. A register of the permits issued will be established. There will almost certainly be organised trading in the permits involving, but not limited to, energy producers[2]. Markets for derivative instruments, such as futures and options are also likely to develop. There will be some form of an acquittal process under the ETS, and penalties are likely for non-compliance.

All of this has implications for government finance statistics, the national accounts and statistics about the market participants themselves, and in particular energy producers. The ABS will need to ensure that its statistics properly capture this new type of economic activity. It is likely that markets will emerge – particularly in derivative instruments – prior to the actual implementation of the ETS, so the statistical issues will need to be thought through, and the right collection mechanisms put in place, within a relatively short time-frame.

A particular issue is the treatment of the permits themselves in economic statistics. One of the issues considered in the update of the 1993 SNA[3] was 'contracts, leases and licenses'. Within this broad topic, emission permits are considered to be 'permits issued by government to undertake a specific activity'. They are specifically mentioned in paragraph 17.342 of the draft update, which concludes that 'the permits … constitute assets and should be valued for the market price for which they can be sold'. Preceding paragraphs describe how payments to government for the issuance of permits to undertake a specific activity are to be treated as taxes. The permit asset itself first appears in the other changes in the volume of assets account and changes in value, both up and down, are recorded in the revaluation account. When a permit is traded, a transaction in the asset between the two institutional units involved in the transaction is recorded.

Derivative instruments based on emission permits will be treated in the national accounts in a similar manner to other derivative treatments.

The updated 1993 SNA will be introduced in Australia's national accounts in the second half of 2009, which ties in well with the timing of the implementation of the ETS. The national accounting treatment of emission permits will also be implemented in other ABS economic statistics, including the balance of payments and government finance statistics around this time.

---

[2] The point of obligation is likely to be set at the point of emission where practicable. Where transaction costs are lower than the cost of distortions that may arise, the point of obligation may be set upstream or downstream of the energy production as appropriate.

[3] All of Australia's economic statistics use the SNA as the underlying conceptual basis, so the national accounting treatment of the permits will flow through to other economic statistics where relevant.

As well as ensuring that the new economic activity generated by the ETS is properly reflected in economic statistics, the ABS will be keen to ensure that there are appropriate statistics about the issuance, acquittal and trading of the permits. Well-functioning markets need to be underpinned by good information, and statistics on turnover, price etc for the permits and associated derivative instruments will be important. It may, however, not necessarily be the role of the ABS to produce such statistics; instead it may be sensible for them to be produced as a by-product of the regulatory function or by the organiser(s) of the market or markets. If this is the case, the ABS will be keen to work with these producers as part of the national statistical system to both provide any assistance in the production of relevant statistics and to ensure that the needs of users for information to support decision making is being met.

As well as statistics on market activity in emission permits, the emission market will need to be underpinned by other, relevant statistics, just as financial markets are underpinned by regular and high quality statistics in areas such as the national accounts, balance of payments and the consumer price index. In particular, the ABS has been advised that participants in the emission permits market will likely be seeking high quality quarterly information on emissions themselves. Currently, such statistics are only available annually, with a lag of about two years. The Australian Government has recently commenced a program to streamline and upgrade the reporting of energy-related information as part of various regulatory processes by establishing a National Greenhouse and Energy Reporting System (NGERS). The System will be administered by a statutory office holder – the Greenhouse and Energy Data Officer (GEDO) – within the DCC. The ABS is working closely with the DCC in the design of the System, including providing advice on units, classifications and standards. The will also work closely with the GEDO to maximise the statistical opportunities that the scheme offers, including the possibility of more frequent and timely statistical data on energy production and usage and associated emissions. An important feature of the legislation underpinning NGERS is that it enables the ABS to obtain unit-record information for statistical purposes.

Measuring the economic, social and environmental impacts of the ETS

The implementation of an ETS in Australia will almost certainly have significant economic, social and environmental impacts that will need to be understood, and that in themselves are likely to the subject of policy decisions. For example, it is expected that the ETS will cause price 'shocks' that will impact on the consumer price index, and have implications for monetary policy. Some of these impacts – particularly the economic ones -- may be felt prior to the introduction of the ETS as the likely 'forward' price of carbon is factored into decision making processes. It is important that the ABS understands the potential for these impacts, so that these can be taken into account in making decisions about the range and frequency of its various statistics leading up to and following on from the implementation of the ETS, so that statistical methods can be checked to determine that impacts associated with the ETS will be properly captured in the statistics, and so that, wherever possible, the particular impacts of the ETS can be identified[4].

[4] This last mentioned issue – that of identifying wherever possible the particular impacts of the ETS – can be challenging. In 2000 the Australian Government introduced a new taxation system which, among other things, included a goods and services tax. While the ABS sought to measure the impact of

So far, only preliminary consideration has been given to identifying the statistics that are most likely to be affected. However, it is clear that a wide range of statistics will be affected, including but not limited to:

- the consumer price index (with there also being issues around the limitations of using a fixed-weighted index and the best time for reweighting the CPI)
- the household expenditure survey, to understand changes in household expenditure patterns
- the balance of payments, to understand the impact of non-resident involvement in the emission permits market
- capital expenditure statistics, to understand the impact on investment decisions
- research and development and innovation statistics, to understand how businesses and other institutions are dealing with challenges associated with higher energy prices
- profit statistics, to understand the impact on business profitability
- transportation statistics, to understand changed transport patterns
- household and business energy use statistics, to understand changed patterns in the usage of energy
- regional economic and social statistics, to understand impacts that are likely to vary from one region to another, with 'energy intensive' regions[5] likely to be particularly impacted
- statistics on renewable energy, to understand the impact of changes in relative prices for various energy sources and to understand responses to complementary initiatives to the ETS to encourage the use of renewable energy.

In the next few months the ABS will work closely with key users, and in particular the DCC and Treasury, to better understand the potential impacts and what needs to be done to prepare for them.

Concluding remarks

The design and implementation in Australia of the ETS has significant statistical implications, some of which are directly associated with the ETS and some of which are indirect. The ABS has had the opportunity to work closely with the key policy agencies working on the ETS and it has been able to secure some additional resources to support the development of the ETS. Continued close dialogue with the policy agencies, as well as other users with an interest in the statistical impact of the ETS, will be essential if the ABS is to ensure, by its efforts and in working in partnership with others, that these impacts are properly captured in statistics produced by the national statistical system.

---

this, it was unable to fully quantify all of the impacts. Nonetheless, the efforts of the ABS in quantifying what it was able to were appreciated by users.

[5] Such regions could include those with significant energy producing activities or with significant energy-using industries.

In recent years, the ABS has had a focus on increasing in its relevance and responsiveness, particularly in terms of 'cutting edge' policy issues. The ETS offers a tremendous opportunity for the organisation to show its capabilities, and so far the results are pleasing. However, there are challenges. Many of the statistical issues are complex, and ensuring that the right skills are available is a particular issue that needs to be addressed. Also, the statistical impacts will be felt across a number of areas within the ABS, so coordinating the work will be important (as will coordinating communication with key external stakeholders). So far, the ABS has not established formal processes to do this, but it is likely to shortly establish such processes under the oversight of relevant senior managers. A lot of work needs to be done in a relatively short period of time, so good project management will be essential.

Peter Harper
Deputy Australian Statistician
Population, Labour, Industry and Environment Statistics
Australian Bureau of Statistics

April 2008

Integrated Environmental and Economic Accounts for Tradeable Carbon Dioxide Emission Permits

Thomas Olsen, Statistics Denmark

Paper prepared for the Conference on Climate Change and Official Statistics,
Oslo, Norway 14-16 April 2008

Integrated Environmental and Economic Accounts for Tradeable Carbon Dioxide Emission Permits

Statistics Denmark
2008

Contact information:

Thomas Olsen

Senior Adviser
National Accounts - Environmental Accounts
Statistics Denmark
Sejrogade 11
DK-2100

Phone: +45 39 17 39 17
Direct: +45 39 17 38 28
E-mail: Tol@dst.dk

Table of contents

1 INTRODUCTION 3
2 INTEGRATED ENVIRONMENTAL AND ECONOMIC ACCOUNTING 3
3 THE EMISSION TRADING SCHEME 5
4 ECONOMIC ASPECTS OF THE PERMITS FLOW THROUGH THE ECONOMY 7
4.1 Permit creation 7
4.2 Agents in the emission trading scheme 7
4.3 Other agents 8
5 PHYSICAL FLOWS OF THE CO_2 PERMITS 8
5.1 Information to be gained from the Environmental Accounts 9
5.2 Results from a Danish experience 10
6 MONETARY FLOWS OF THE CO_2 PERMITS 14
7 APPLICATIONS 16
8 SUMMARY 17
9 REFERENCES 18
10 APPENDIX: THEORY ON TRADEABLE PERMITS 19

1 Introduction[1]

Purpose

It is the purpose of this paper[2] to introduce the Environmental-Economic Accounting framework as a means for organising data on carbon dioxide (CO_2) permits[3] and a tool for analysing both the physical and the monetary aspects of the CO_2 permits as well as the CO_2 permits flow through the economy.

Background

The background of this paper is that the common European market for tradeable CO_2 emission allowances came into force on 1 January 2005.

Reduction obligations

The CO_2 allowance market was established to help meeting the CO_2 reduction obligations that the EU, and thereby also Denmark, is committed to under the Kyoto Protocol.

The common European CO_2 reduction goals concerning the Kyoto Protocol are laid down in Council Decision (2002/358/EC). The legal obligations imply that the EU member states have, on average, to emit 8 per cent less CO_2 than in 1990 over the period 2008-2012. According to the Council Decision, Denmark is legally obliged to carry out a reduction of 21 per cent compared to the 1990 level.

Complex market

The European emissions trading scheme, which is part of the global carbon dioxide (CO_2) emission allowance market, constitutes a complex market for CO_2 permits. Therefore, means for organising data on permits, which enable analyses of the permits' flow, are crucial. The Environmental-Economic Accounting framework provides such a means.

Structure

This paper consists of 7 sections. Section 2 provides a general overview of the Integrated Environmental and Economic Accounting framework and highlights the advantages of organizing environment and energy statistics and data on environmentally related taxes and subsidies as well as data on CO_2 permits in an accounting framework. Sections 3 and 4 outline the structure and features of the emission trading scheme. Section 5 deals with the flow of the physical CO_2 permits through the economy, whereas section 6 outlines the monetary flow. Section 7 briefly describes applications and describes how data on permits could be organised in order to be used as input in macroeconomic models. Section 8 summarises the key points of the paper.

The theoretical background of introducing a system with tradeable CO_2 emission permits is outlined in the appendix.

2 Integrated Environmental and Economic Accounting

Integrated Environmental and Economic Accounting provides a way of structuring information that allows decision-makers and others to gain new insights into public policy issues. It enables to systematically analyse the impact of the environment on the economy, and *vice versa*.

SEEA-2003

The System of Integrated Environmental-Economic accounting (SEEA-2003) is a satellite system of the System of National Accounts (SNA), which is the standard system for organising economic information. As such, it has a similar structure to the

---

[1] The views expressed in this paper are those of the author and do not necessarily reflect the views of Statistics Denmark.

[2] This paper is based on the report 'Integrated Environmental and Economic Accounts for Tradeable Carbon Dioxide Emission Permits – Denmark 2005' (Statistics Denmark, 2006). The report benefited from funding by the European Commission, Eurostat, through grant agreement no. 71401.2005.001-2005.292, Action 3 for the study entitled "Environmental Statistics and Accounts – Other Economic Instruments - Permits".

[3] In this paper, the terms permit and allowance are used synonymously.

1993 SNA and shares common definitions and classifications. It provides an integrated set of aggregate environmental and economic information from which indicators of performance can be derived. These can be at the sectoral and macroeconomic level, as well as at more detailed levels, and may guide resource managers and policy makers alike.

Coherent framework

The SEEA-2003 provides a set of definitions, classifications, statistical accounts and tables to analyse the interactions between the economy and the environment. It provides a framework for organizing environment and energy statistics together with economic information using common concepts, definitions and classifications. It also enables to analyze links between different environmental domains (e.g. between energy, pollution, land, water, etc). In short, the SEEA-2003 provides an integrated framework allowing trade-offs to be examined.

The integration of information on the economy and energy allows decisions and policies to be designed, analysed and reviewed for effectiveness. In the case of energy and associated air emissions, policy-makers need to be aware of the likely consequences for the economy of implementing or increasing targets for reducing air emissions. Similarly, those industries making extensive use of energy resources in production processes need to be aware of the long-term consequences of their use on the environment (e.g. increased temperatures, reduced water availability).

Analytical value

The accounting system has substantial analytical value. By integrating economic and environmental and energy accounts it becomes possible to develop a coherent and consistent set of indicators to examine the implications for different patterns of production and consumption of the environment and energy resources, or conversely, to examine the economic consequences of maintaining given environmental standards. Because economic activities and their environmental impacts, in terms of resource use and emissions, can be compared directly, the system makes it possible to calculate intensities and to derive various kinds of indicators. Moreover, since it uses an input-output structure it can be used for modelling; for example the impact of introducing specific energy taxes or CO_2-permits on resource consumption and emissions.

Consistent analyses

Overall, the Environmental-Economic Accounting framework enables the user to make consistent analyses of the economic activity, the use of energy, the associated air emissions, environmentally related taxes and subsidies as well as the flow of CO_2 permits.

SEEA-2003 under revision

It should be mentioned that in the SEEA-2003, which is currently under revision, permits are seen as an economic asset and as a result of that the link to the physical aspects, the consumption of energy and the associated air emissions are not mentioned, i.e. only the monetary flow is dealt with.

Physical flows should be accentuated

Therefore, the current description in the SEEA-2003 on how permits, e.g. CO_2 permits should be dealt with is likely to be changed. In 2008, based on the revised 1993 SNA, possible solutions are going to be discussed[4]. However, the description in the revised SEEA should not be limited to the guidelines in the revised 1993 SNA. As is shown in section 5, the link to the physical flows should be accentuated.

[4] The discussion is to take place within the United Nations London City Group on Environmental Accounting.

3 The Emission Trading Scheme

International market

All EU member states are part of the European market for tradeable CO_2 emission allowances. The CO_2 allowance system also includes an opportunity for cross border trade. Initially, this is only possible within the EU. In the future, it will also be possible to trade globally.

Future market

At the moment, it is only selected industries primarily the manufacturing industries and the energy supply industries, which are legally obliged to be part of the CO_2 allowance market. However, even now there are talks about extending the emission trading scheme so that also emissions from international air traffic will be included in the scheme.

Increasing interest

That there is an increasing interest in the CO_2 allowance market can also be seen by the fact that there is an increasing number of companies which engage in trade with the CO_2 allowances. These companies are not legally obliged to be part of the emission trading scheme, but act on the market because of arbitrage opportunities. For instance, the investment bank Morgan Stanley has announced that they will increase their engagement in the CO_2 allowance market.

Danish carbon market

The Danish market for tradeable CO_2 allowances is, as already mentioned, a part of the European market. The Danish CO_2 allowance system is, in general, designed in such a way that the majority of the allowances are allocated free of charge (grandfathering), while the aim is that a minority will be sold.

Places of production

The unit level for the units that are used for the allowance system is the production unit (local kind-of-activity unit, KAU), not the companies themselves.

In Denmark, 374 places of production are covered by the allowance system in 2008 (251 in electricity and heating, 116 in industry and 7 in offshore industry). Inside the EU c 10,000 places of production are covered.

Allowances are only imposed on selected industries

The industries on which the allowance system is imposed are chosen using a *least-cost* consideration, i.e. it is the industries that are expected to be able to make the most effective reduction of their CO_2 emissions at the cheapest cost, which are included in the allowance system. In Denmark, the annual CO_2 emissions of the industries in the allowance system constitute approximately half of the CO_2 emissions accounted for by the Kyoto Protocol.

The permits

One permit gives the right to emit 1 ton of CO_2. The permits only exist electronically in the allowance register. The permits, besides being marked with the validity period, are marked with information on the country in which the permit was issued, a unique serial number and information on the type of permit.

The different types of permits

The permits that are allocated or acquired at an auction can be traded and used in all EU countries (EU permit). The proceeds from the sale of the permits go to the Treasury.

It is also possible to acquire permits using what is referred to as the flexible mechanisms, i.e. by taking part in the following types of projects:

CDM (*Clean Development Mechanism*) – projects. This involves a company taking part as a (co)financier of a project with a partner in a developing country. The CO_2 reduction that the project implies is credited the (co)financier and the company thereby gets a larger number of permits at its disposal.

JI (*Joint Implementation*) – projects. Similar to CDM projects, but where the partner is in a country, which is also obligated to reduce CO_2 emissions according to the Kyoto Protocol. It has been possible to take part in this type of arrangement since the beginning of 2008.

CDM and JI projects have to be approved by the United Nations (UN) before they can be put into action. From 2008 a ceiling will be placed on how large a part of a production unit's CO_2 reduction can be paid for using CDM and JI credits. The credits from the CDM and JI projects can also be traded.

The initial distribution of the allowances

The initial distribution of the allowances is laid down in the National Allocation Plan (NAP) on the basis of the average historic emissions of the places of production for specific base years. The NAP has to be approved by the European Commission.

The main part of the permits are allocated free of charge (grandfathering). For the period 2008-2012, 90 per cent of the permits will be free of charge, while 10 per cent of the permits can be purchased. The selling method and the price are currently unknown. Finally, three per cent of the permits are set aside in the so-called growth pool for new places of production and new activities.

When the permits have been allocated to a company, they are considered to be the property of that company.

The permits can be used freely in the period 2008-2012. Permits that have not been used can be transferred to the period 2013-2018.

If a company chooses to reduce or cease its production, the production unit will not lose the permits it has already been allocated.

Trading in permits

Anyone can purchase and trade in permits, provided they have an account in a European allowance register. The Danish companies that are included by the allowance system have to be registered in the Danish allowance register. Anyone else who wishes to act on the allowance market can choose for themselves in which allowance register they wish to be recorded. The same applies to private citizens.

Until 2008 registration was limited to the European registers. From 2008, it is possible to record in the allowance registers of any country included in the Kyoto Protocol.

In the case of Denmark, this means that the permits can be traded between Danish agents, agents in the EU and finally between agents in other countries.

Sanctions

If the allocated or purchased permits are exceeded by the actual CO_2 emissions, the company is fined (From 2008, 100 Euro/ton). Besides the fine, the number of permits with which the production unit has exceeded their allowance is deleted from their allowance in the following period.

CO_2 credits

As already mentioned, CDM and JI projects are some of the strategies that it is hoped will contribute to helping Denmark meet its reduction obligations under the Kyoto Protocol.

Funds

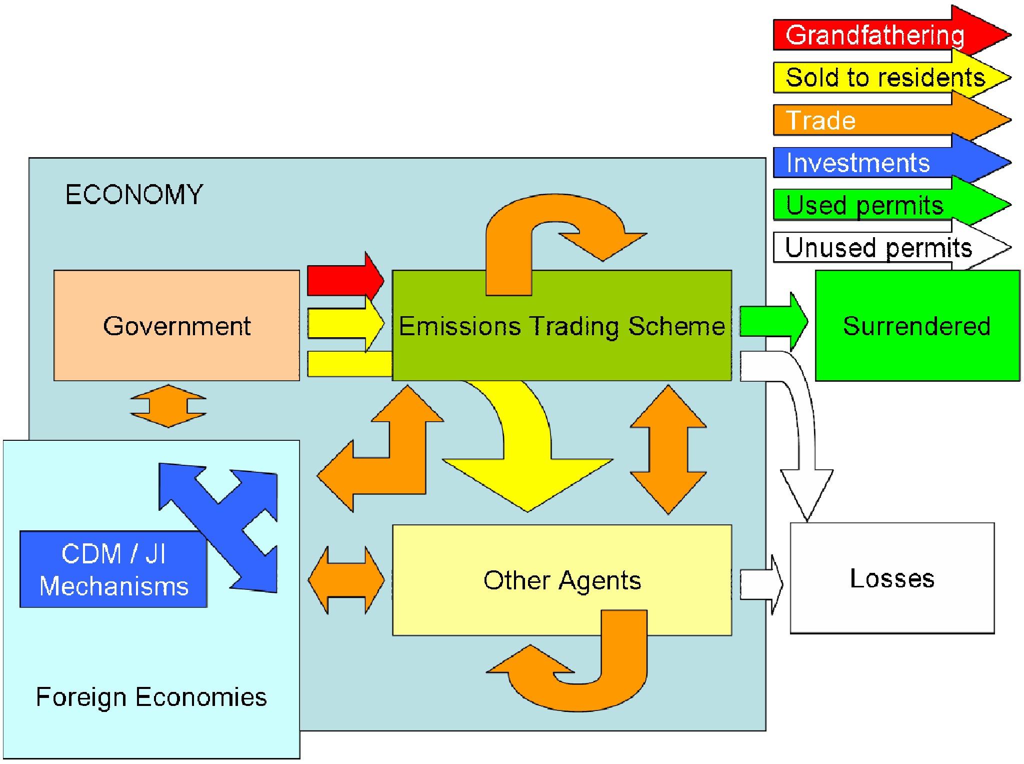
In Denmark, the Government has put aside funds for CDM project and JI projects. The price per permit from the projects is expected to be substantially below the market price, i.e. below the costs for most of the domestic reduction initiatives. The permits are not earmarked to relieve the reduction targets of specific industries.

The fund is going to finance CO_2 credits from CDM and JI projects in developing countries and from countries in Central and Eastern Europe, i.e. investments in technologies that lead to more effective energy use. The credits thus attained can be interpreted as the return on these investments.

4 Economic aspects of the permits flow through the economy

The focal point in this section is the flow of permits, which we would like to describe within the Environmental-Economic Accounting framework.

Figure 1: The flow of permits through the economy



4.1 Permit creation

Creation and issue

Either the permits are created and issued by the Governments or they are created as a consequence of the use of the flexible mechanisms. This is how the permits enter the economy in the first place.

The flow of the permits through the economy then depends on whether or not they end up with agents for whom it is mandatory to be part of the emission trading scheme.

4.2 Agents in the emission trading scheme

Grandfathering

The companies that are legally obliged to be in the allowance system will typically receive a number of permits free of charge from the Government corresponding to their historic emission of CO_2 (grandfathering).

If this number of permits is enough to cover the company's emission of CO_2, the company can choose to save (banking) extra permits for later use, or the company can choose to sell the permits to a domestic or foreign company. It can be to a company that is also included in the allowance system, or it can be to a company or person that is not included in the allowance system.

If the number of permits is not enough to cover the company's emission of CO_2, then the company has two ways of obtaining extra permits.

The first way is to buy permits from a domestic or foreign company. Also, the Government might have permits in an extra pool, which it is possible for the company to buy. The Government could decide to sell the permits at a fixed price, but normally the Government would sell the permits at an auction.

The other possibility is to use the flexible mechanisms. That is, the company can choose to finance a project that causes a reduction in CO_2 emissions. The company will then get a number of permits corresponding to the reduction in CO_2 emissions.

When a company has surrendered a permit because of its CO_2 emission, the permit will cease to exist. The permit is then no longer available for agents in the economy.

If a permit is not surrendered before it expires, it is lost. The economic value is then zero. However, from 2008, the permits can be transferred to the next period, so the loss is unlikely to happen.

4.3 Other agents

Other companies and private citizens

Companies and private citizens, which are not legally obliged to be part of the allowance system, can also choose to participate in the allowance market.

The reason for choosing this is to make a profit by speculating in how the price of the permit will develop. These agents are only in the market because of arbitrage opportunities.

Agents who are in the market because of the opportunities for arbitrage must remember to sell the permit before it expires, since it will otherwise have no economic value. As already mentioned, this was only relevant until 2008, from which, the permits can be transferred to the next period. Only companies in the allowance system can surrender permits.

Environmental organisations and environmentalists could also have an interest in buying permits and not using them, because they could in this way contribute to the reduction of the CO_2 emissions[5].

5 Physical flows of the CO_2 permits

The CO_2 permit registry

The most important source, to the description of flows of the CO_2 permits, is the CO_2 emission permit registry, which can be thought of as an internet bank in which, the deals that take place are registered. In Denmark, the register is administered by the Ministry of Climate.

Object of the register

The object of the register is not to effect contact between buyer and seller. Neither does the price appear from the register. The deal is registered in the form of a transfer from the seller's account to the buyer's account.

The information in the allowance register creates an opportunity for compiling a large amount of statistics, which are relevant for the environmental accounts as well as the national accounts.

Method

The data obtained from the CO_2 allowance register is at micro level. Therefore, the task is to allocate the information in the emission registry to the national accounts industry classification[6], which is also the basis for the environmental accounts.

[5] This has actually been the case in Sweden where private individuals bought allowances in order to give them as Christmas gifts.

[6] In Denmark, the national accounts industry classification is based on the NACE industry classification.

More details For a more comprehensive description of the emission permits registry and the methods used, in order to relate the data to the national accounts industry classification, please see Statistics Denmark (2006).

5.1 Information to be gained from the Environmental Accounts

New information in the Environmental Accounts When the data on the permits has been related to the national accounts industry classification, it is possible to imagine a number of statistics on the permits. Some of the possibilities are mentioned below.

Depending on the level to which environmental accounts already exist in a country, it would be relevant to juxtapose information on the industries' use of energy, the associated air emissions, and the industries' payment of energy taxes and in addition to this, a series of information on the CO_2 permits.

Policy relevant For politicians and other decision-makers, information on the CO_2 permits is very policy relevant. If described within the Environmental-Economic Accounting framework, the CO_2 emission permits accounts would be able to answer the following questions:

Questions that could be answered

– What are the origins of the permits?
  a. Are they issued by the Government?
  b. Are they purchased from abroad by the industries? Or by the Government?
  c. Or did the permits enter the economy as a consequence of the use of the flexible mechanisms (joint implementation or clean development mechanism)?

– From where have the industries received the permits?
  a. Are they received from the Government for free (grandfathering)?
  b. Are they bought, maybe at an auction, from the Government?
  c. Are they bought from a foreign company?

– Who owns / holds the permits?
  a. Is it the energy companies or manufacturing industries that need to have permits in order to undertake their activities?
  b. Or is it investment banks which are only interested in the permits from an arbitrage perspective?

– Who is actually trading with the permits?
  a. What is the trade in volumes?
  b. What is the value of the trade?
  c. What is traded internally between the industries (not only the industries included in the allowance system)?
  d. What are the imports and the exports of the permits?

– What is the relationship between the use of energy and the CO_2 emissions?
  a. What is it for the total industries?
  b. What is it for that part, which is included in the emission trading scheme?

- What is the relationship between the emissions of CO_2 and the emission permits?
    a. What is the relationship between the industries' total CO_2 emissions and that part of the industries CO_2 emission, which is included in the emission trading scheme?
    b. Have the industries acquired a sufficient number of permits compared to their CO_2 emissions?
    c. If not, how big fines have had to be paid (from 2008, 100 Euro/ton).

- What is the relationship between the CO_2 permits and other taxes / subsidies?
    a. The cost for CO_2 permits in relation to the environmental related taxes.
    b. The value of the permits received for free in relation to other environmental related subsidies.

Link to the economy

As already mentioned, the description of the flow of CO_2 permits within the Environmental-Economic Accounting framework not only makes it possible to analyse the relationship between CO_2 permits and other environmental domains. Because of the link to the national accounts, the description of the CO_2-permits within the Environmental-Economic Accounting framework also enables analyses of the relationship between the economic activity and the CO_2 permits, e.g. output, gross value added, employment etc.

5.2 Results from a Danish experience

Results from the Danish experience

Below, some of the results from a Danish experience are shown. See also Statistics Denmark (2006).

Danish experience only covers a subset of the emission trading scheme

However, it is only a subset of the emission trading scheme, which is covered in the tables. It is only that part of the emission trading scheme, in which it is mandatory to be part of, which is covered in the tables. This is due to the fact that it was not possible to gain full access to the Danish emission registry. Where information is missing this is indicated by a *NA*. Therefore, the tables should not be seen as a comprehensive description of the Danish carbon market, but more as what is possible and as an introduction to the possibilities.

Initial allocation

Table 1 shows the initial allocation of the allowances. It is only the industries *Agriculture, fishing and quarrying*, *Manufacturing* and *Electricity, gas and water supply* which are affected by the emission trading scheme. The allowances are valid from 2005 to 2007. The companies can choose for themselves in which year they want to use the allowance. However, the allowances cannot be surrendered after 2007.

Table 1 **Initial allocation of the tradeable permits**

	Industries	2005	2006	2007
		1 000 allowances / 1 000 tonnes CO_2		
	Total	**40 046**	**30 679**	**30 590**
	Permits to be sold by the Government	1 675	1 675	1 675
	Permits for new entrants and new activities	1 000	1 000	1 000
	Total industries	**37 371**	**28 004**	**27 915**
1	Agriculture, fishing and quarrying	3 056	2 292	2 292
2	Manufacturing	7 525	5 601	5 601
3	Electricity, gas and water supply	26 790	20 111	20 022
4	Construction	0	0	0
5	Wholesale and retail trade; hotels, restaura.	0	0	0
6	Transport, storage and communication	0	0	0
7	Financial intermediation, business activities	0	0	0
8	Public and personal services	0	0	0

Table 2 shows the number of permits grandfathered to the industries and the (verified) emissions actually caused by the industries being part of the emissions trading scheme. The table shows that the companies had to surrender fewer allowances than were actually provided for them in 2005. This implies that it is possible for the companies, because they have a surplus of allowances, either to increase their emissions in 2006 and 2007 or to sell that surplus on the allowance market.

Table 2 **Allocated permits, verified emissions and surrendered permits 2005**

	Industries	Allocated permits	Verified emissions	Surrendered permits
		1 000 allowances / 1 000 tonnes CO_2		
	Total	**37 371**	**26 476**	**26 471**
	Households	0	0	**0**
	Total industries	**37 371**	**26 476**	**26 471**
1	Agriculture, fishing and quarrying	3 056	2 328	2 328
2	Manufacturing	7 525	5 452	5 438
3	Electricity, gas and water supply	26 790	18 696	18 704
4	Construction	0	0	0
5	Wholesale and retail trade; hotels, restaura.	0	0	0
6	Transport, storage and communication	0	0	0
7	Financial intermediation, business activities	0	0	0
8	Public and personal services	0	0	0

Verified emissions

Table 3 shows the verified emissions compared to the total emissions accounted for in the Danish air emissions accounts. The total emission is exclusive of the Danish operated ships and aeroplanes bunkering abroad. The emissions relevant for the emissions trading scheme account for 58 pct. of the industries CO_2 emissions and for 46 pct. of the total emissions, including the households.

Table 3 **Verified emissions and total emissions 2005**

	Industries	Verified emissions	Total emissions
		1 000 tonnes CO_2	
	Total	**26 476**	**57 911**
	Households	0	11 941
	Total industries	**26 476**	**45 970**
1	Agriculture, fishing and quarrying	2 328	4 723
2	Manufacturing	5 452	6 530
3	Electricity, gas and water supply	18 696	25 059
4	Construction	0	1 297
5	Wholesale and retail trade; hotels, restaura.	0	1 345
6	Transport, storage and communication	0	5 203
7	Financial intermediation, business activities	0	529
8	Public and personal services	0	1 284

Even though, there was generally a surplus of allowances in 2005, a few companies did not manage to surrender the correct amount of allowances. These companies had to pay a fine as a consequence of that. The fine amounts to 40 € / ton in 2005, so the total fine paid by the companies amounted to 0.56 mill. Euro.

This amount of allowances, which is not surrendered, is referred to as the amount of under surrendered permits.

Table 4 **Under surrendered permits and payment of fines 2005**

	Industries	Under surrendered permits	Fine
		1 000 allowances	€
	Total	**- 14**	**563 480**
	Households	0	0
	Total industries	**- 14**	**563 480**
1	Agriculture, fishing and quarrying	0	0
2	Manufacturing	- 14	563 440
3	Electricity, gas and water supply	0	40
4	Construction	0	0
5	Wholesale and retail trade; hotels, restaura.	0	0
6	Transport, storage and communication	0	0
7	Financial intermediation, business activities	0	0
8	Public and personal services	0	0

Until now, the tables have only showed information on that part of the emissions trading scheme of which the companies are legally obliged to be part. However, in order to account for the entire CO_2 allowance market table 5 has been established.

As already mentioned, because of all the problems connected with gaining access to the most detailed information in the CO_2 allowance register, it is not possible to fill out table 5 completely. Therefore, where data has not been available, the cells in the table are marked with a *NA*.

Asset account

The places of production are allocated an average number of permits every year, so it is necessary to establish a sort of asset account for every industry, in order to show: the stock at the beginning of the year; the supply in the form of allocated and purchased permits, and credits from JI and CDM projects; the amount of used permits, including those that may have to be given back because of fines in the previous period; and finally the stock at the end of the year. The closing stock provides the opening stock for the year YYYY+1. Thus, table 5 takes into account all transactions with CO_2 allowances.

The number of allocated permits in column (2) equals the amount of the allocated permits. Cf. table 1.

If information had been available on the trade with allowances, the industries' purchase of allowances would have been registered in column (3), whereas the amount of allowances sold should be registered in column (6). Allowances originating from CDM and JI projects should be registered in the columns (4) and (5).

Table 5 **Balance sheet 2005**

Industries	Opening stock (1)	Allocated (2)	Purchased (3)	CDM credits (4)	JI credits (5)	Sold (6)	Surren-dered allowan-ces (7)	Surren-dered (fines, etc) (8)	Closing stock (=1+...+5-6-7-8)
	1 000 allowances / 1 000 tonnes CO_2								
Total	**0**	**37 371**	**NA**	**NA**	**NA**	**NA**	**26 471**	**0**	**10 901**
Households	0	0	NA	NA	NA	NA	0	0	0
Total industries	**0**	**37 371**	**NA**	**NA**	**NA**	**NA**	**26 471**	**0**	**10 901**
1 Agriculture, fishing and quarrying	0	3 056	NA	NA	NA	NA	2 328	0	728
2 Manufacturing	0	7 525	NA	NA	NA	NA	5 438	0	2 087
3 Electricity, gas and water supply	0	26 790	NA	NA	NA	NA	18 704	0	8 086
4 Construction	0	0	NA	NA	NA	NA	0	0	0
5 Wholesale and retail trade; hotels, rest.	0	0	NA	NA	NA	NA	0	0	0
6 Transport, storage and communication	0	0	NA	NA	NA	NA	0	0	0
7 Financial intermediation, business active.	0	0	NA	NA	NA	NA	0	0	0
8 Public and personal services	0	0	NA	NA	NA	NA	0	0	0

The number of surrendered allowances in column (7) should equal the verified emissions. Cf. table 2.

If the production unit emissions exceeds the number of permits surrendered then, as already mentioned and besides the fine, the number of permits with which the production unit has exceeded their allowance is deleted from their allowance in the following period. This is accounted for in column (8). See also table 4.

Table 6 **Balance sheet 2006**

Industries	Opening stock (1)	Allocated (2)	Purchased (3)	CDM credits (4)	JI credits (5)	Sold (6)	Surren-dered allowan-ces (7)	Surren-dered (fines, etc) (8)	Closing stock (=1+...+5-6-7-8)
	1 000 allowances / 1 000 tonnes CO_2								
Total	**10 901**	**28 004**	**NA**	**NA**	**NA**	**NA**		**0**	
Households	0	0	NA	NA	NA	NA		0	
Total industries	**10 901**	**28 004**	**NA**	**NA**	**NA**	**NA**		**0**	
1 Agriculture, fishing and quarrying	728	2 292	NA	NA	NA	NA		0	
2 Manufacturing	2 087	5 601	NA	NA	NA	NA		14	
3 Electricity, gas and water supply	8 086	20 111	NA	NA	NA	NA		0	
4 Construction	0	0	NA	NA	NA	NA		0	
5 Wholesale and retail trade; hotels, rest.	0	0	NA	NA	NA	NA		0	
6 Transport, storage and communication	0	0	NA	NA	NA	NA		0	
7 Financial intermediation, business active.	0	0	NA	NA	NA	NA		0	
8 Public and personal services	0	0	NA	NA	NA	NA		0	

The closing stock in 2005 equals the opening stock in 2006. However, it is important to remember that banking is not possible between the two periods 2005 – 2007 and 2008 – 2012. Therefore, the opening stock in 2008 is going to be zero. Hence, it is very important to be aware of the rules in relation to banking between the different periods.

Trade, imports and exports

Tables on the domestic trade and the external trade should also be a part of the system. However, due to the fact that it was not possible to gain access to the CO_2 allowance register, it was not possible to provide any information in the Danish experience on the trade or the foreign trade with the CO_2 allowances. It is also important to be aware that the imports and the exports of allowances also have implications for the balance of payments.

Table 7 **Purchase / sale and imports / exports of the permits 2005**

	Industries	Purchase of permits (or Sale of permits)	Of which imports (or Of which exports)
		1 000 allowances / 1 000 tonnes CO_2	
	Total	**NA**	**NA**
	Households	NA	NA
	Total industries	**NA**	**NA**
1	Agriculture, fishing and quarrying	NA	NA
2	Manufacturing	NA	NA
3	Electricity, gas and water supply	NA	NA
4	Construction	NA	NA
5	Wholesale and retail trade; hotels, restaura.	NA	NA
6	Transport, storage and communication	NA	NA
7	Financial intermediation, business activities	NA	NA
8	Public and personal services	NA	NA

6 Monetary flows of the CO_2 permits

The underlying idea of the monetary flows of the allowances is first of all to get an idea of the size of the CO_2 market and the agents who act on this market. Secondly, the monetary account is expected to provide the basis for actually implementing the economic flows associated with the European emissions trading scheme and the global CO_2 market in the national accounts.

All allowances have an economic value

A large proportion of the allowances are, as already mentioned, given for free to the companies being part of the emissions trading scheme. However, because the allowances represent an economic value for the companies we put a value on the allowances.

Allowances sold by the Government either by auction or directly have clearly an economic value.

Agents on the carbon market

A number of traditional energy companies have established units that mediate and trade with CO_2 permits. Their approach is not only to use the CO_2 permits themselves, but rather to make money on the permits through arbitrage. They also have a function as traders and they act on the global market.

In the same way, financial companies also act on the allowance market. A look at the list of members, which are part of the Nordic Power Exchange (Nordpool) market for CO_2 allowances, show that the list contains energy companies as well as financial institutions.

Size of the carbon market

The carbon market has grown dramatically over the last few years. The increase from 2006 to 2007 was 64 pct. so that the global CO_2 permit market had a total value of c € 40 bn. (Borsen, 2008). For 2008, the expectation is that the value of the global market could reach c € 60 bn. (Information, 2008).

The European market constitutes approximately two thirds of the global market.

Observed prices In connection to the establishment of the European allowance market, a number of CO_2 trading market places[7], which buyers and sellers can use, have been established.

Valuation The valuation of the CO_2 permits is based on the physical CO_2 permits accounts as well as observed prices.

Overall method The overall method for establishing the monetary account is to multiply the amount of allowances by the observed market price for the allowances.

Unfortunately, we do not have information on the extent to which the companies make use of financial instruments, such as price contracts in order to provide against a rise in the future allowance price. Therefore, the monetary CO_2 permits accounts as shown below are valued at the average spot price.

Results The value of the allowances valued at the average spot market price in 2005 appears from table 8. Based on the average spot market price in 2005[8], which was c € 17, the value of the permits allocated to the Danish industries is c € 0.64 bn.

[7] See for instance:
www.cantorco2e.com
www.europeanclimateexchange.com
www.eex.de
www.exaa.at
www.nordpool.com
www.powernext.fr
www.pointcarbon.com

[8] In 2005, the lowest price was observed in January at c € 7 whereas it peaked in July at c € 30.

Table 8 Balance sheet 2005

National Accounts Industries	Opening stock	Allocated	Purchased	CDM credits	JI credits	Sold	Surren-dered allowan-ces	Surren-dered (fines, etc)	Closing stock
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(=1+...+5-6-7-8)
	Mill. €								
Total	**0**	**636**	**NA**	**NA**	**NA**	**NA**	**451**	**0**	**186**
Households	0	0	NA	NA	NA	NA	0	0	0
Total industries	**0**	**636**	**NA**	**NA**	**NA**	**NA**	**451**	**0**	**186**
1 Agriculture, fishing and quarrying	0	52	NA	NA	NA	NA	40	0	12
2 Manufacturing	0	128	NA	NA	NA	NA	93	0	36
3 Electricity, gas and water supply	0	456	NA	NA	NA	NA	318	0	138
4 Construction	0	0	NA	NA	NA	NA	0	0	0
5 Wholesale and retail trade; hotels, rest.	0	0	NA	NA	NA	NA	0	0	0
6 Transport, storage and communication	0	0	NA	NA	NA	NA	0	0	0
7 Financial intermediation, business active.	0	0	NA	NA	NA	NA	0	0	0
8 Public and personal services	0	0	NA	NA	NA	NA	0	0	0

Allowances sold by the Government

In addition to the value shown in the table above comes the value of the allowances which it is possible for the Government to sell. Cf. table 1. Based on the same average price the value of this amount of allowances is c € 29 mill.

7 Applications

Analyses

Together with the environmental accounts, the physical CO_2 permits accounts and the monetary CO_2 permits accounts set the scene for a series of analyses in themselves. This could be analyses of the relationship between environmental domains or analyses of the interaction with the economy.

Macroeconomic models

In order to use the data on the CO_2 permits as input in macroeconomic models, it would be useful to break down the value of the surrendered allowances by type of energy product.

Allowances broken down by type of energy

The use of the monetary CO_2 permits accounts, would be to use the value of the surrendered allowances (column 7 in table 8) broken down by the type of energy causing the emissions.

This breakdown is believed to be useful for economic modelling and analysis, because of the fact that the price of the allowances is going to affect the companies' behaviour in relation to their choice of energy mix.

The method for this breakdown would be to start from the air emissions accounts and to use the breakdown of the CO_2 emissions by industry and by type of energy as the key for the breakdown.

The breakdown of the value of the allowances by type of energy would provide an extra price level that can be added to the regular price levels[9] in the monetary energy accounts. In Denmark, the monetary energy accounts are already used as input in macroeconomic models.

[9] That is, basic prices, trade margins, taxes, VAT and purchasers prices.

8 Summary

Integrated Environmental-Economic Accounting provides a way of structuring information that allows decision-makers and others to gain new insights into public policy issues. It enables to systematically analyse the impact of the environment on the economy, and *vice versa*.

In relation to CO_2 permits, the physical and the monetary CO_2 emission allowance accounts, together with other types of accounts within the framework of Environmental-Economic Accounting, enables decision-makers to answer policy relevant questions.

The description of the flow of CO_2 permits within the Environmental-Economic Accounting framework makes it possible to analyse the relationship between CO_2 permits and the economic activity, e.g. output, gross value added, employment etc.

In summary, the Environmental-Economic Accounting framework enables the user to make consistent analyses of the economic activity, use of energy, the associated air emissions, environmentally related taxes and subsidies as well as the flow of CO_2 permits.

9 References

Alfieri, Alessandra. Olsen, Thomas: Integrated Environmental and Economic Accounting. Paper prepared for the 2nd meeting of the Oslo Group on Energy Statistics (2007).

Borsen: CO_2-kvoter får firmaer til at reducere udslip. Article in the Danish language in the Danish newspaper Børsen. 19 March (2008).

Information: CO_2-handel blomstrer, men prisen er for lav. Article in the Danish language in the Danish newspaper Information. 12 March (2008).

Pearce, David W. and Turner, R. Kerry: Economics of Natural Resources and the Environment. Harvester – Wheatsheaf (1990).

Statististics Denmark: Integrated Environmental and Economic Accounts for Tradeable Carbon Dioxide Emission Permits – Denmark 2005 (2006).

Tietenberg, T. H.: Transferable Discharge Permits and Global Warming from the Handbook of Environmental Economics edited by Daniel W. Bromley. PP. 317 – 352. Blackwell Publishers (1995).

United Nations et al.: Handbook of National Accounting – Integrated Environmental and Economic Accounting. ST/ESA/STAT/SER.F/Rev.1 (final draft). (2003).

United Nations et al.: System of National Accounts (1993).

10 Appendix: Theory on tradeable permits

Pollution control

The tradeable allowance approach to pollution control was first introduced in 1975 in the United States with what is known as the emissions trading program. Since that time the tradeable permit approach has been applied to several areas of environmental policy. Moreover, support for the market approach to environmental control has increased. See Tietenberg (1995).

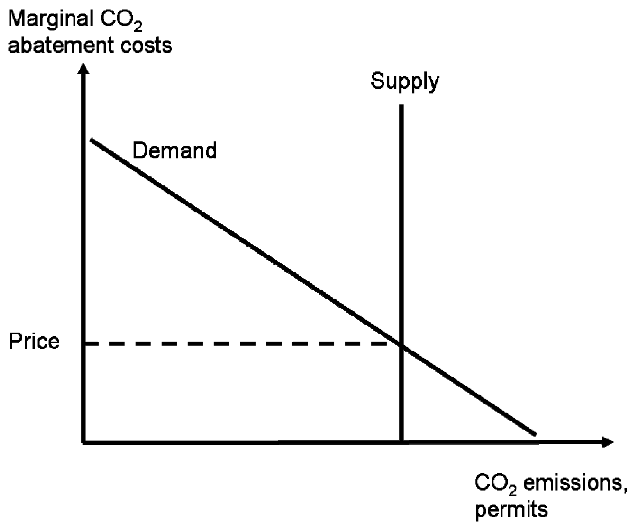
Tradeable allowances

The underlying idea of the introduction of a tradeable CO_2 allowance system is to create scarcity of the right to emit CO_2. A market for trade with permits is thereby created. By establishing a market for emission allowances, the right to emit CO_2 has been given an economic value. This market will encourage companies to carry out reductions in CO_2 where it is cheapest to do so, i.e. where it is most efficient.

The advantage of the allowance system is that the regulating authority, without knowledge of the CO_2 emitters' cost curves, ensures that the CO_2 reductions are made through the market where it is most efficient.

The regulating authority achieves the desired CO_2 reduction by issuing a fixed number of permits (corresponding to the vertical supply curve) in each period, diminishing in number with each new period.

Figure: Marginal costs



Initial distribution

The initial distribution of the allowances can be achieved by selling them, by holding an auction or by *grandfathering* – which is free allocation based on the historic emission levels.

Market adjustment

When the permits are made tradeable, the agents on the market will adjust their reduction effort and the stock of permits, so that the marginal CO_2 reduction costs, corresponding to the demand curve, are equal to the price of the allowance. If the marginal reduction costs are larger than the price of the permit, then the agent will keep the permit and vice versa.

Banking

The regulating authority can decide if the allowances will only be valid for a single period or if the allowances can be saved for future periods. This is called *banking*.

In general, the permits are most liquid if they can be saved for future periods of time, and if permits for future periods are also issued in the initial offering. See Pearce and Turner (1990).

The alternative

The introduction of an optimal (Pigou-) tax on emission of CO_2 will lead to the same solution to the regulation problem as that of the tradeable allowance system. However, to set the precise tax rate it is a necessity for the regulating authority to have complete information on the companies' cost curves.

Session 5 : Conference papers

CAN THE OFFICIAL STATISTICAL COMMUNITY PROVIDE GREATER SUPPORT TO THE IPCC?

Dennis Trewin
Statistical Consultant

1. Introduction

There has been little engagement between the IPCC and the official statistical community. I will not discuss why this might have been the case. Rather I will look forward and argue that improved engagement will be of benefit to both parties in the IPCC's Fifth Assessment Round (FiAR) and that we should explore, with the IPCC, how we official statisticians might better engage with them. There is no point in doing this unless official statisticians have something tho offer. But I am sure as a consequence of this Conference it will be clear that official statisticians have a lot to offer.

I am assuming the scenario approach will be used in the FiAR as it was in the Third and Fourth Assessment Rounds. If so, the official statistical community could be of particular assistance to the development of the scenarios. The IPCC has indicated it will be reviewing the scenarios for the FiAR so it is a good opportunity to have some influence. Regardless, some key official statistics, such as population and economic growth, will be key inputs into the climate models which use the scenarios.

The structure of this paper is as follows. First, I will provide some background to the way the IPCC produces its climate projections. I have assumed that not everyone at the Conference has close familiarity with their work. Those who are familiar with their work can bypass this part of the paper. I will then briefly describe some criticisms of the use of statistics in the last round as a basis for discussing how the official statistical community can assist with the FiAR.

I should say up front what I mean by official statistics. There was some debate as to whether the term 'Official Statistics' or just 'Statistics' should be used to describe the Conference. Critics of the former title suggest the title implies National Statistical Offices only. They suggest it ignores the role played by international statistical organisations or the statistical departments of the Ministries. This is not intended. They should be regarded as part of 'Official Statistics', at least for the purposes of this Conference. If the description had just been 'Statistics' it could have been interpreted as including statistical modellers, biometricians, and the like at universities and research institutions. They play an important role in the analysis of climate change but their work is not part of the deliberations of this Conference. (A statement published by the American Statistical Association, and posted on this Conference web site, outlines that role.) I understand steps have been undertaken by the IPCC to engage more closely with this section of the statistical community.

2. My Credentials

My main credentials for writing a paper of this type are:

i. I was Australian Statistician (CEO of Australian Bureau of Statistics from 2000 until early 2007).

ii. I am Chairman of the Global Executive Board of the International Comparison Programme which is responsible for the production of purchasing power parities. These have the potential to be used to good effect in the FiAR.

iii. I have been a member of the Australian State of the Environment Committee for the last 10 years. It is responsible for producing an independent report on the State of the Environment every 5 years.

3. Background to the IPCC Climate Change Models

According to the IPCC's Summary for Policy Makers, temperatures are expected to increase by about 0.2 degrees per decade over the next two decades for a range of scenarios. That is, temperatures are expected to increase by nearly 0.5 degrees by 2030.

A lot of the projected increase is due to past actions and an increase of about 0.3 degrees would be expected even if greenhouse gas concentrations could be maintained at 2000 levels.

Beyond the next two decades, different outcomes result from the different scenario groups. The 'worst case' A1FI scenarios projects temperature increases of 2.4 to 6.4 degrees (with a best estimate of 4.0 degrees) by the end of the century. Sea levels are projected to increase by 0.26 to 0.59 metres over the same period. Their 'best case' B1 scenario projects temperature increases of 1.1 to 2.9 degrees (with a best estimate of 1.8 degrees) by the end of the century. Sea levels are projected to increase by 0.18 to 0.38 metres.

The following box provides a brief description of the scenario families. It is derived from the IPCC's Summary for Policy Makers.

The scenarios are used to provide inputs into the climate change models. They are not predictions or outcomes – they are intended to be plausible descriptions of how the 21st Century might evolve. The scenarios use a wide range of assumptions about future demographic change, economic growth and technological change. The assumptions range from the very optimistic to the very pessimistic. They are based on the peer reviewed literature. The "best estimates" mentioned above are based on some form of average across the scenarios. The upper and lower limits are based on the most pessimistic and optimistic estimates respectively.

In the Third Assessment Round, the scenarios excluded explicit polices to reduce emissions. In the Fourth Assessment Round, the scenarios included those which incorporated actions that reduced carbon dioxide emissions and stabilised concentrations.

Climate Change Scenarios

The scenarios are based around six basic storylines.

A1 – This describes a future world of very rapid economic growth, global population that peaks in mid century and declines thereafter, and the rapid introduction of new and efficient technologies. Economic convergence among the regions is assumed with a substantial reduction in regional differences in per capita income. There are three subgroups within the A1 family distinguished by the direction of their technological emphasis.

A1FI – fossil intensive energy sources

A1T – non-fossil energy sources

A1B – balanced across all sources

A2 – This describes a very heterogeneous world with emphasis on self reliance and preservation of local identities. Continually increasing population is expected. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented than in other storylines.

B1 – Similar to A1 but with a rapid change in economic structures toward a service and information economy with reductions in material intensity and the introduction of clean and resource efficient technologies.

B2 – This storyline has an emphasis on local solutions to economic, social and environmental sustainability. Population continues to increase but at a slower rate than A2. Intermediate levels of economic development are assumed with less rapid and more diverse technological change than in the A1 and B1 storylines.

4. Some Criticisms of the Fourth Assessment Round

These are summarised below and expanded in the following paragraphs.

1. The first criticism is the so called Castles/Henderson criticism. Because exchange rates rather than purchasing power parities are used to compare the size of economies in the climate change models, the economic growth of developing countries (where exchange rates tend to be undervalued compared with purchasing power parities) has an upward bias where economic convergence is assumed as is the case in many of the scenarios (see next point). This is explained in more detail below.

2. The second criticism is the economic convergence assumption in many of the scenarios. For example, in the A1 scenario average incomes are predicted to converge by nearly 2% per annum which is much higher than historically has been the case. For the A2 scenario the convergence is a much more realistic 0.5% per annum. (For the B1 and B2 is assumed convergence is somewhat

higher than that assumed for the A2 scenario but a lot lower than for A1.) While there is likely to be a move in this direction, the most likely outcome is that most of the developing countries of today will still be behind the more developed countries and hence the global growth rates will be overstated.

3. The population growth rate assumptions used in the climate change models reflect the growth rates of 20 years ago not those of today. During this time, global population growth has decreased from 2.5% per annum to 1.2% per annum.

The first criticism is the one that has had most public debate. I will try to explain what happens as a result of using market exchange rates rather than purchasing power parities. The main impact is at the starting point for the models – 1990. Because market exchange rates are used to compare the size of developing economies, there is a tendency to under-estimate the size of developing economies compared with the developed economies which in turn are over-estimated. This is because market exchange rates tend to under-estimate the 'true' comparative costs of developing countries (ie goods and services seem relatively cheap in developing countries). So, with a lower base than there should be and the economic convergence assumptions, growth rates tend to be exaggerated for developing countries. The impact is clearly shown for scenarios A1 and B1 in Table 1 below where more rapid economic convergence is assumed and the growth rates seem high compared with the World Bank for example.

Table 1 Comparative Annual Growth Rates in GDP (on a per capita basis)

Scenario/Source	Annual Growth Rate (%)
A1	3.1
B1	2.4
US Department of Energy	1.9
B2	1.8
World Bank	1.8
International Energy Authority	1.5
A2	1.0

The economic growth rates for the A1 and B1 scenarios are much greater than for the US Department of Energy's, World Bank's or IEA's economic projections. I believe the reason is what I have outlined above ie the non-use of purchasing power parities, combined with convergence assumptions for many scenarios. In fact the data set above indicates that the economic convergence assumption rather than the non-use of PPPs may be the main reason for the high level of economic growth implicit in these scenarios.

The differences are greatest for the so-called Africa/Latin America/Middle East region (which comprises most of the developing countries) where the growth rates in the A1 and B1 scenarios are clearly above the upper end of the projections from the DoE, World Bank and IEA whilst the A2 and B2 scenarios fall near the centre. This reinforces my argument that the non-use of PPPs, together with the convergence assumption, may be leading to an upward bias in the economic growth assumptions in the A1 and B1 scenarios. This, in turn, will lead to estimates of excessive growth in projected energy demand.

The impact of these flaws may not be as great as perceived. The ‘bias’ affects both economic growth rates and energy intensity in compensating ways as GDP is the denominator in energy intensity ratios. Also a high proportion of the greenhouse gases are already in the system. Independent sources suggest the overall impact may result in an upward bias of up to 0.5 degrees in the best estimate from the relevant scenarios.

I turn now to the third criticism about population growth assumptions. The official population projections produced by the international community are not used because they are not in peer reviewed literature. Yet they are probably more authoritative and up-to-date than most in the literature. Population growth has slowed remarkably in recent years and many of the peer reviewed projections would not have caught up to this more recent trend. This has been driven by changes in Africa and Asia in particular. In both continents, fertility rates have declined substantially and in Africa mortality rates have increased because of the AIDS epidemic. Mortality has also increased in the former Soviet countries chiefly because of lifestyle reasons. The differences for the regions mentioned above are so great that some commentators have suggested they stretch credibility. The IPCC have noted this in their report and indicate that they plan to incorporate lower population projections in the scenarios being developed for the fifth report.

The annual growth rate from the medium United Nations population projections is 13 to 19% lower than those in B2 and will be even lower than those in A2. However they are broadly consistent with those in A1 and B1. In fact they show a peak slightly early than the medium UN projection. Scenarios A2 and B2 assume continually increasing population whereas A1 and B1 assume a population that peaks mid century.

It is interesting to note that difference between the best estimates of temperature by the end of the century for A1 and A2 as well as B1 and B2 is 0.6 degrees. This might give an order of magnitude estimate of the impact of the different population assumptions.

Does it matter? I believe it does matter. If the assumptions within the climate change model are systematically on the high (or low) side, then the predictions from those models are likely to be systematically on the high (or low) side. The models are not linear so this cannot be stated with absolute certainty but it is highly likely. In a paper I presented to the OECD World Forum in 2007, I showed that by restricting the range of scenarios to those reflecting more recent economic and population growth (the B1 family), climate change projections to the end of the century are 1.3 – 2.5 degrees, with a most likely outcome of 1.8 degrees compared with the IPCC projections of 1.3-6.2 degrees. The lower level of climate increase is still very important but the policy interventions may be very different to those that would be necessary for the more extreme temperature predictions. Policy interventions do have a cost and unnecessary expenditure on addressing climate change may be at the expense of policy interventions on health, education or even other aspects of the environment.

The IPCC has been incredibly successful in organising the collective effort of many of the world’s top scientists. It has been also been incredibly successful in its advocacy role. It has had a fundamental role in convincing global and national policy makers that climate change is an issue that has to be addressed. That battle has largely been won. I would argue that its major challenge now is to provide the best possible evidence base to support policy makers as address impacts and adaptation and mitigation strategies.

Eleven of the last twelve years rank among the 12 warmest years in recorded temperature history. The trend increase is about 0.2 degrees over the decade. The IPCC says this is consistent with the predictions from climate change models. Others say the trend in temperature increase over the last decade has been more like 0.1 degrees and less than what is predicted by climate change models. Temperature trends are extremely difficult to estimate over such a short period. The differences are largely due to the treatment of 1998 which was an extremely warm year due to a strong El Nino effect. If my conjecture is right you would expect the climate change models to over-estimate the trend because the economic and population growth assumptions, on average, are on the high side. But there is insufficient evidence to indicate whether this is correct or not.

5. Where might the official statistical community assist?

The models used to assess future climate change, and the scenarios on which they are based, are very complex. I will not pretend to be across the detail. My main purpose in this section is to identify those areas of official statistics which are of greatest importance for this work. Before doing this, it is useful to think of energy related emissions as being a function of population growth, per capita GDP growth, changes in energy intensity, and changes in the carbon intensity of the energy that is used.

Energy is not the only source of greenhouse gas emissions but they are the main source. There are other sources of greenhouse gases such as agriculture which need to be considered as do sinks such as forestry. Land use is an important consideration to climate change projections.

I discuss six main areas of potential use of official statistics – (a) population projections, (b) economic growth projections, (c) purchasing power parities, (d) energy efficiency and carbon intensity ratios, (e) land use statistics, and (f) the cost (in GDP terms) of emission mitigation strategies.

There are other areas of interest such as the extent of industry restructuring (eg from high energy use manufacturing to low energy use service industries) and expenditure shares on energy and transport. Energy price data might also be important to many forms of analysis. These data will be available in developed statistical systems and perhaps more could be done to aggregate data at the national level.

(a) Population projections

> I would suggest the population projections produced by the United Nations Population Division are far more authoritative and up to date than the peer reviewed literature and these projections should provide the basis for the scenarios used in the FiAR. The global population projections also have regional dissections. In fact they are available at the country level.
>
> They are authoritative and up to date because there is widespread consultation as part of each update of the projections. For example, a Technical Working Group comprising many of the world's leading demographers was established to assist the UN Population Division with the 2300 projections. Furthermore, a

range of projections are produced using different assumptions on future fertility rates, mortality rates, etc. The main scenarios are the high, medium and low projection but if necessary, it would not be difficult to make alternative projections using different assumptions.

The best source for the purposes of the IPCC would be "World Population to 2300". The estimates are also available on www.unpopulation.org. They are an extension of the 2002 revision of the World Population Projections.

As a matter of interest, the medium projection shows a peak at 9.22b in 2075 before slowly declining and slowly decreasing. In effect, the global population is expected to stabilise at about 9 billion with this projection. The distribution of population will change dramatically over this period. Over this century, Europe's population will decline from 12.0 to 5.9% of the global population whilst Africa's share will increase from 13.1% to 24.9%.

The high projection shows a steadily increase in global population with some decline in the rate of growth whereas the low projection shows a lower peak population and earlier at 2040.

The majority of National Statistical Offices have demographers. It should be possible to assemble a panel of demographers (which could include some of those involved in the 2300 World Population Projections) to assist with the development of population projections to be used in the scenarios.

(b) Economic Growth Projections

I would suggest the World Bank's estimates of global economic growth provide a more authoritative and timely source of economic growth than the peer reviewed literature. These estimates are produced as part of annual process of developing "Global Economic Prospects". The main emphasis is on the central scenario but the process also includes low growth and high growth scenarios. The current projections are to 2030. They are compiled using a Linkage model developed by the World Bank and, from what I understand of the Linkage model, it may not be difficult to extrapolate economic growth assumptions beyond 2030.

Some of the key assumptions in their model include demographic trends, savings and investment behaviour, technological change, productivity improvement and the extent of globalisation of these variables. Their model is multi-sectoral and multi-regional so estimates can be produced at those levels.

These central estimates suggest continuing economic convergence but nowhere near full convergence. It is estimated to be about 0.3% per annum, higher than this in the Asian region but lower in the African and Latin American regions.

For the central economic growth estimates, the growth rates for high income countries are estimated to be 2.5% and, for developing countries, estimated to be 4.2%. This is somewhat slower than recent experience. On a per capita basis, these growth estimates will be lower of course. Global population growth rates have been about 1.2% in recent years.

The World Bank provides estimates of the size of the global economy on a purchasing parity basis using the $US as a numeraire. The size of the global economy has been revised downwards as a consequence of the recently released purchasing power parity estimates. These were calculated from the 2005 round of the International Comparison Programme (ICP). The reasons for the reduction are shown in the following box.

The base year for the climate change models used in the Fourth Assessment Round was 1990. Perhaps, the base year will be shifted for the FiAR. In simplistic terms, I wonder if a way of overcoming the Purchasing Power Parity controversy is to adjust the size of the relative economies using purchasing power parities. This could be the starting point for the models. The economic growth rate, population growth rate, and other assumptions within the scenarios could then be applied to the climate change models.

The official statistical community might be able to assist with the application of purchasing power parities. They are also the main source of much of the input data that is used in the models of economic growth. This includes data on demographic trends, investment and productivity.

BOX – REDUCTION IN THE SIZE OF THE GLOBAL ECONOMY

The main reason for the reduction is the reduction in the size of the Chinese and Indian economies compared with previous estimates.

China had never been included in the ICP. Purchasing power parities were estimated on the basis of a small research study in the early 1980's. These were extrapolated up until the end of 2007 when revised estimates of purchasing power parities became available. These were the first purchasing power parity estimates for China to be based on actual data. It appears that the extrapolated estimates of purchasing power parities were lower than what they should have been.

The last prices collected for India were in respect of 1985. These have been extrapolated forward. Again it appears that the extrapolated prices were lower than they should be.

The rapid development of China and India may have led to upward pressure on prices. There has been rapid growth in investment and a significant proportion of this has been in imported capital equipment.

(c) Purchasing Power Parities (PPPs)

PPPs in respect of 2005 have recently been published. These are much better based than previous estimates. The amount of money spent on data collection and data compilation was considerably more than in previous rounds. Proper governance arrangements were put in place that ensured there was close coordination between the global and regional bodies involved in the International Comparison Programme. More detailed data was collected. Considerably more countries were involved in data collection, hence the purchasing power parities were much more data based. For example, data was collected in China for the first time ever and data was collected in India for the first time since the mid 1980s.

In the absence of actual price data, PPPs are based on imputations and the lack of validity of PPPs based on actual data. It is not surprising that there have been significant revisions upwards in PPPS for India and China and consequently revisions downwards in the per capita GDP for both countries.

PPPs are published by the World Bank. They are available on their web site as well as in printed form. The official statistical community, especially the World Bank, can assist with the provision of PPP data and how to apply these PPPs in practice.

It may not be necessary to all scenarios. But it may be prudent to use them in some benchmark scenarios so the impact of not using PPPs can be properly assessed.

(d) Energy Use and Carbon Intensity

Energy use and energy efficiency ratios, and their change over time, are important inputs into the climate change models. These statistics are available through official statistics. They are available through the UN Statistics Division and/or the International Energy Authority. Ratios based on per unit of population and per unit of GDP are both available. The energy statistics are dissected by a range of energy sources. But these data bases only reflect some of the data that is available. The OECD countries, in total, use most of the provided energy. Much more detail is available on energy use than is indicated in these summary statistics.

For example, a range of energy production and energy use statistics with sectoral breakdowns are available from most OECD countries. Energy efficiency ratios can be derived from this data. Some countries have produced energy accounts which might be of use, even if only on a case study basis.

Many countries will also have data on energy source and how that has changed over time. This facilitates the estimation of changes in carbon intensity.

The IEA also provides data on energy prices and carbon dioxide emissions from fuel consumption. The latter are available on a per capita basis, per unit of GDP basis, and per unit of GDP(PPP) basis.

The FAO produces statistics on biomass at the national level. The use of biomass for energy is generally of greater importance to developing countries.

(e) Land use cover data

FAO is the main source of land use and land cover data. It maybe somewhat limited for the purposes of the IPCC but, for many countries, more detailed data may be available through the National Statistical Offices. They also have other data that is either linked to a spatial framework, or has that potential, which might be useful for climate change analysis. This includes data from their population censuses, agriculture censuses and economic censuses or business registers. This data is useful for climate change analysis in a variety of ways. It may be easier to work with an intermediary such as CIESIN, Columbia University to present the available data consistently at the global level. Some imputation will be necessary as the data is incomplete.

(f) The cost of emission strategies

NSOs have a range of data resources that are useful for these purposes. This includes the System of National Accounts. Input-output tables can be particularly useful for analysing 'what if' effects such as the introduction of emission trading and other emission strategies. Likewise, environmental accounts can also be useful for these purposes.

These data are not available for all countries but it may suffice to have country level studies of the impact and extrapolate the results of these studies.

Reductions in economic growth will be important in adjusting the economic growth estimates used in the scenarios. Knowledge of this is also important from a national policy perspective.

6. A Way Forward

Effective use of official statistics could make a real difference to (a) the scenarios that underpin the climate change models, and (b) parameters used in climate change models. In reality official statistics are essential ingredients to climate change models but it is not clear that they have been used as effectively or extensively as they might have been. It is well known that quality is best addressed at the source rather than through remediation. In a similar light, it may be best that an official statistician with the appropriate background and knowledge and links to the broader statistical community. work with the IPCC on (a) the development of the scenarios to be used in the Fifth Assessment Round, and (b) the Working Group that is involved in application of the climate change models to ensure an appropriate level of engagement.

Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

CONFERENCE PRESENTATIONS

Addressing Climate Change and Sustainable Development Challenges Together: The Role of Statistics

Professor Mohan Munasinghe

Vice-Chair, Intergovernmental Panel on Climate Change (IPCC), Geneva
Chairman, Munasinghe Institute for Development (MIND), Colombo
Hony. Senior Advisor to the Government of Sri Lanka, Colombo

Keynote speech at Session 1
of the UN Conference on Climate Change and Official Statistics
Oslo, 14 April 2008

WHY ? is climate a threat to future human development

Climate Change (CC) undermines Sustainable Development (SD) and unfairly penalizes the poor

WHY ? is climate a threat to future human development

Climate Change (CC) undermines Sustainable Development (SD) and unfairly penalizes the poor

HOW ? can we better understand CC-SD links and identify specific issues

Analyze how CC affects SD and vice versa using the Sustainomics framework

WHY ? is climate a threat to future human development

Climate Change (CC) undermines Sustainable Development (SD) and unfairly penalizes the poor

HOW ? can we better understand CC-SD links and identify specific issues

Analyze how CC affects SD and vice versa using the Sustainomics framework

WHAT? are the practical solutions and policy options to be implemented that will integrate CC responses into SD strategy (from global to local levels)

Many examples of good practice available.

Improved data and statistics will play a key role.

Introduction to Climate Change

Brief Overview of IPCC AR4 Main Findings: Risk to Sustainable Development

IPCC Assessment Process

IPCC was created in 1988 by WMO and UNEP

Four assessment reports have been prepared and progressively improved our understanding of climate change:

1. Climate Change 1990
2. Climate Change 1995
3. Climate Change 2001
4. Climate Change 2007

Fifth assessment report planned during 2008-2013

IPCC reports review the most recent and critical scientific information. They are intended to be policy relevant but not policy prescriptive.

IPCC Fourth Assessment Report (AR4)

Three Main Working Groups:

I. Science of Climate Change

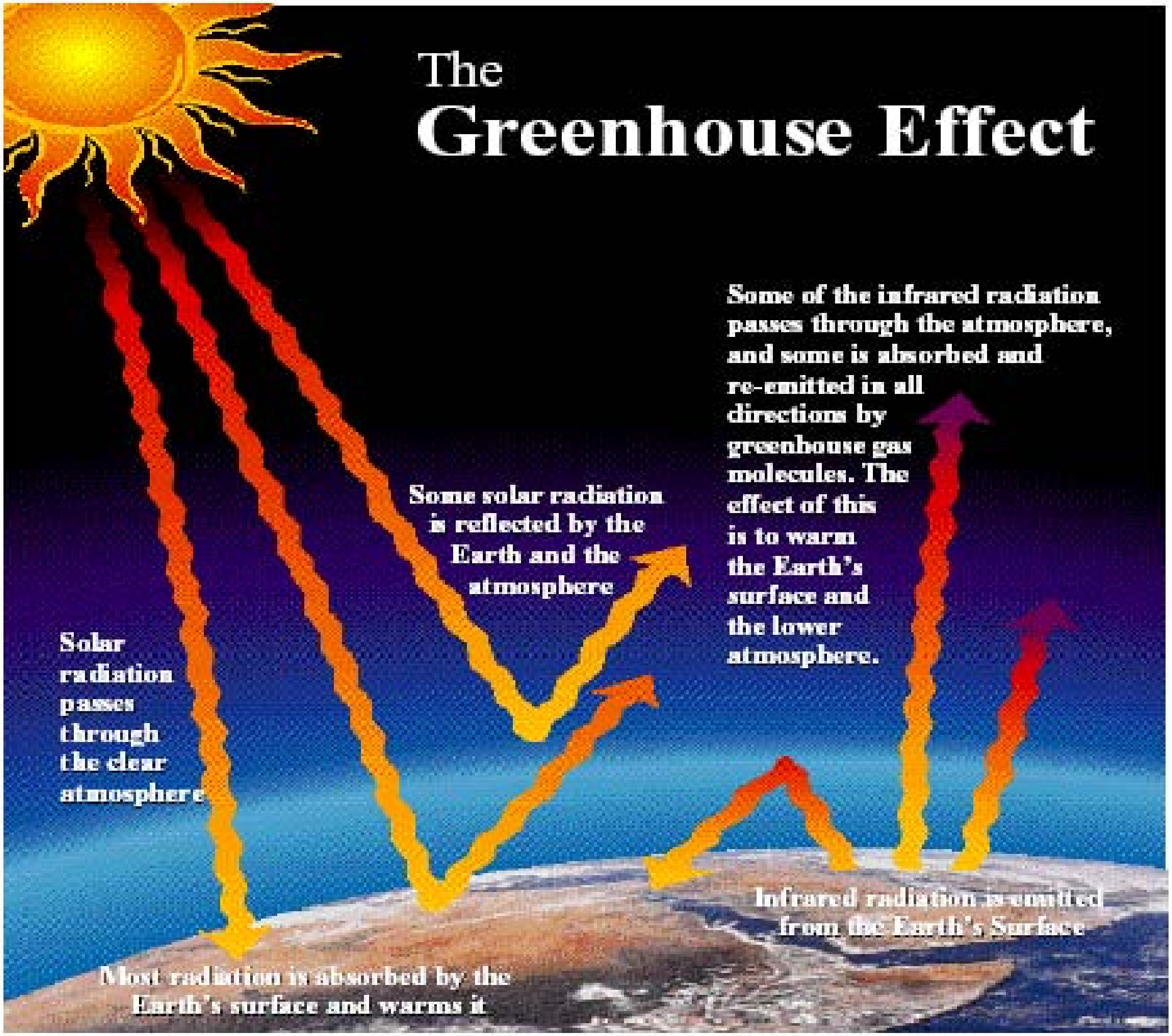
II. Impacts, Adaptation and Vulnerability

III. Mitigation

Synthesis Report

Task Force on National Greenhouse Gas Inventories

Over 2000 leading scientists worldwide, were involved in writing, reviewing and editing the AR4.


The
Greenhouse Effect
Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Some solar radiation is reflected by the Earth and the atmosphere
Solar radiation passes through the clear atmosphere
Infrared radiation is emitted from the Earth's Surface
Most radiation is absorbed by the Earth's surface and warms it

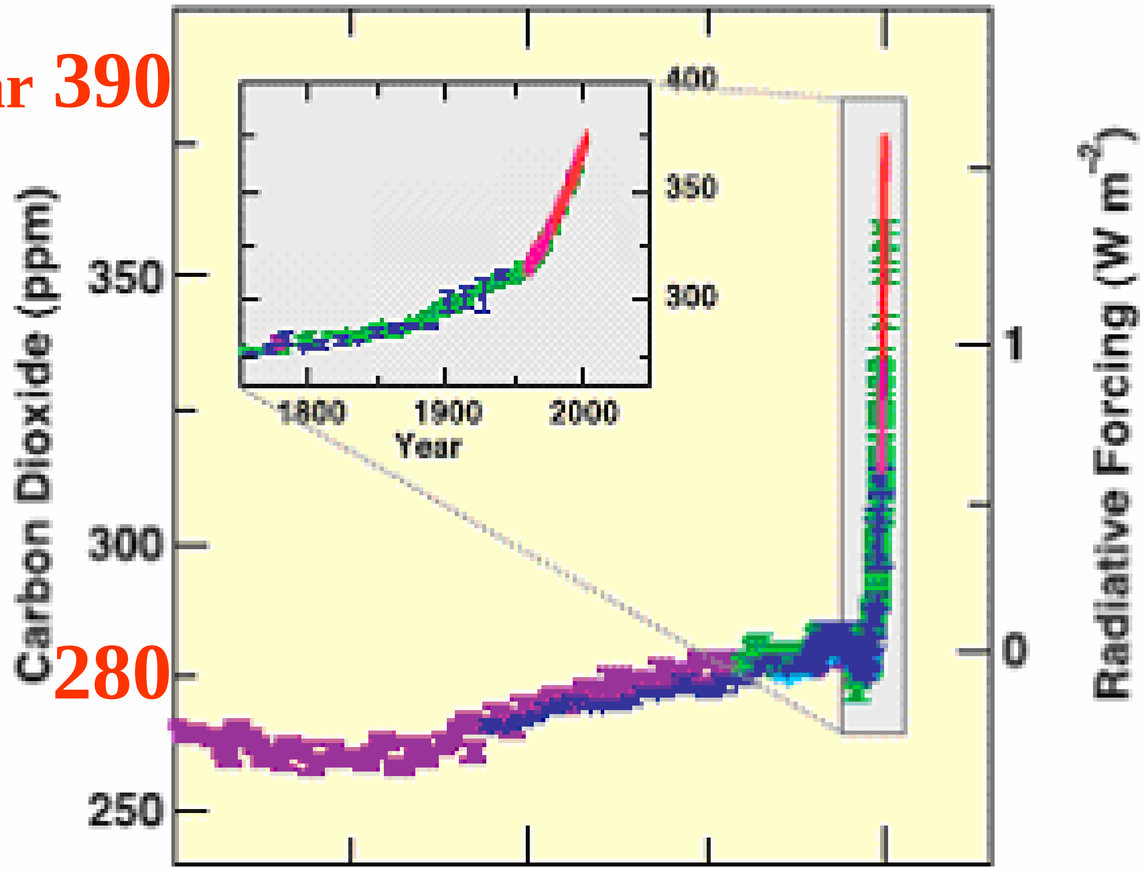
IPCC AR4 – Summary of Main Findings

- **Global warming in unequivocal. Total radiative forcing of the climate now is unprecedented in several thousand years, due to rising concentrations of GHG (CO2, CH4 & NO2).**
- **Humans activities since the 18th century are very likely to have caused net warming of Earth's climate, dominating over the last 50 years. More temp. and sea level rise is inevitable, even with existing GHG concentrations.**
- **Long term unmitigated climate change would likely exceed the capacity to adapt, of natural managed and human systems.**
- **Poor countries and poorest groups will be most vulnerable to warming, sea level rise, precipitation changes and extreme events. Most socio-economic sectors, ecological systems and human health will suffer.**
- **Adaptation measures are available, but must be systematically developed**
- **Mitigation technologies are also available, but better policies and measures (PAM) are needed to realize their potential.**
- **Making development more sustainable (MDMS) by integrating climate change policy into sustainable development strategy is most effective solution.**

MAIN DRIVER

Changes in CO2 from ice core and modern data

Now: near 390



Pre-ind: 280

-10,000 -5,000 TODAY (years)

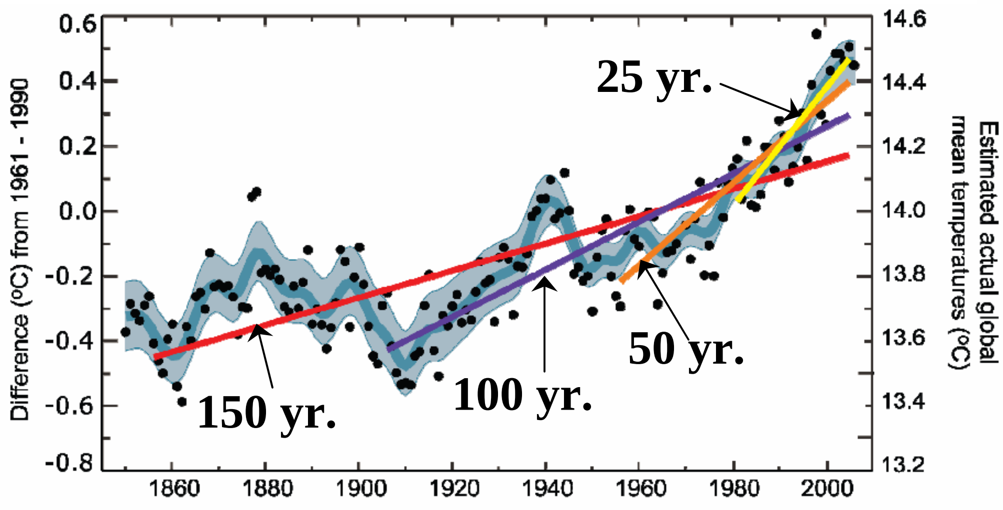
Other drivers include methane, nitrous oxide and aerosols

M I N D

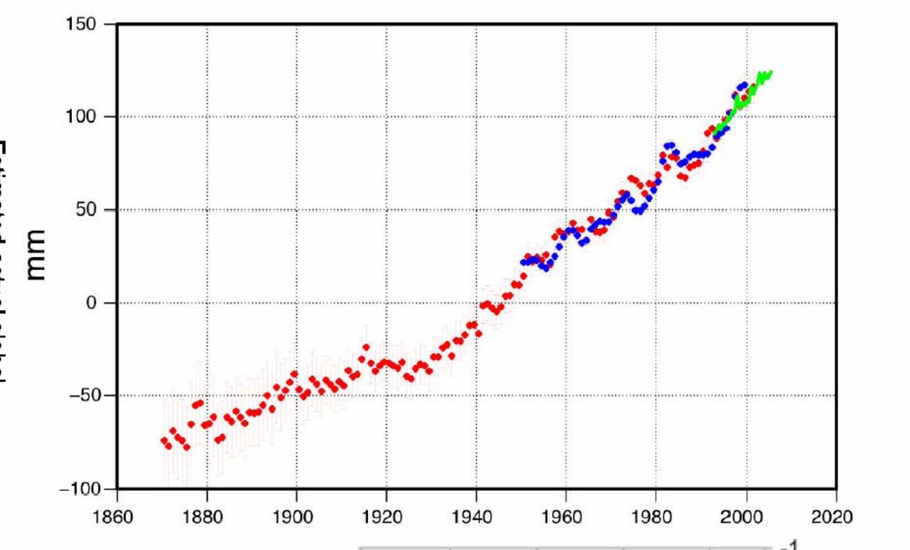
Munasinghe Institute for Development

RESULT: Mean Temp., Sea Level and Ice Cover

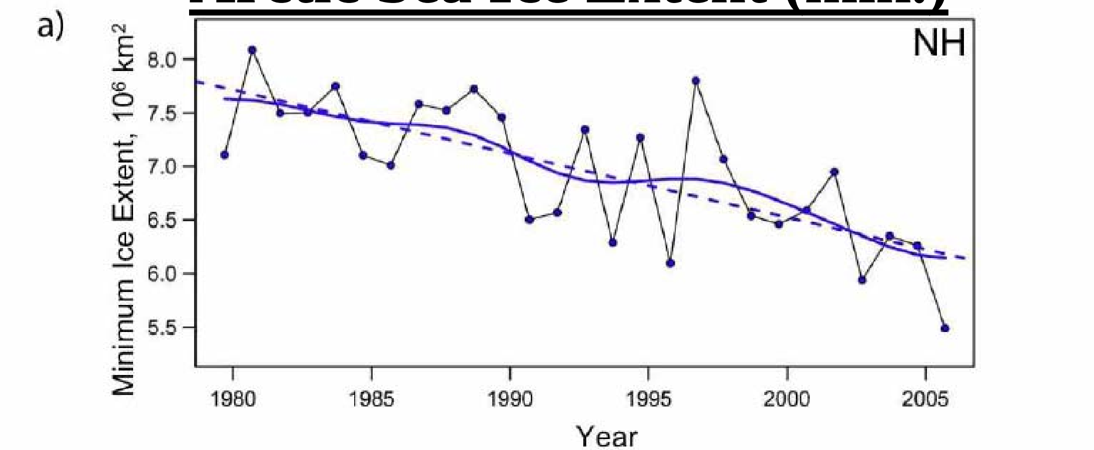
Mean Temperature



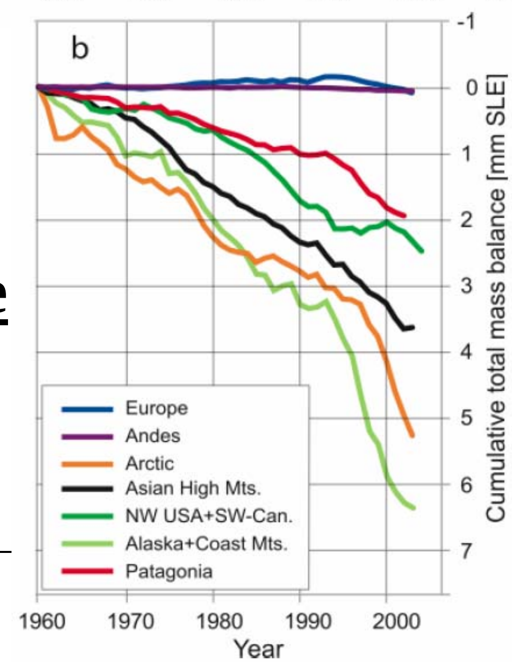
Mean Sea Level



Arctic Sea Ice Extent (min.)



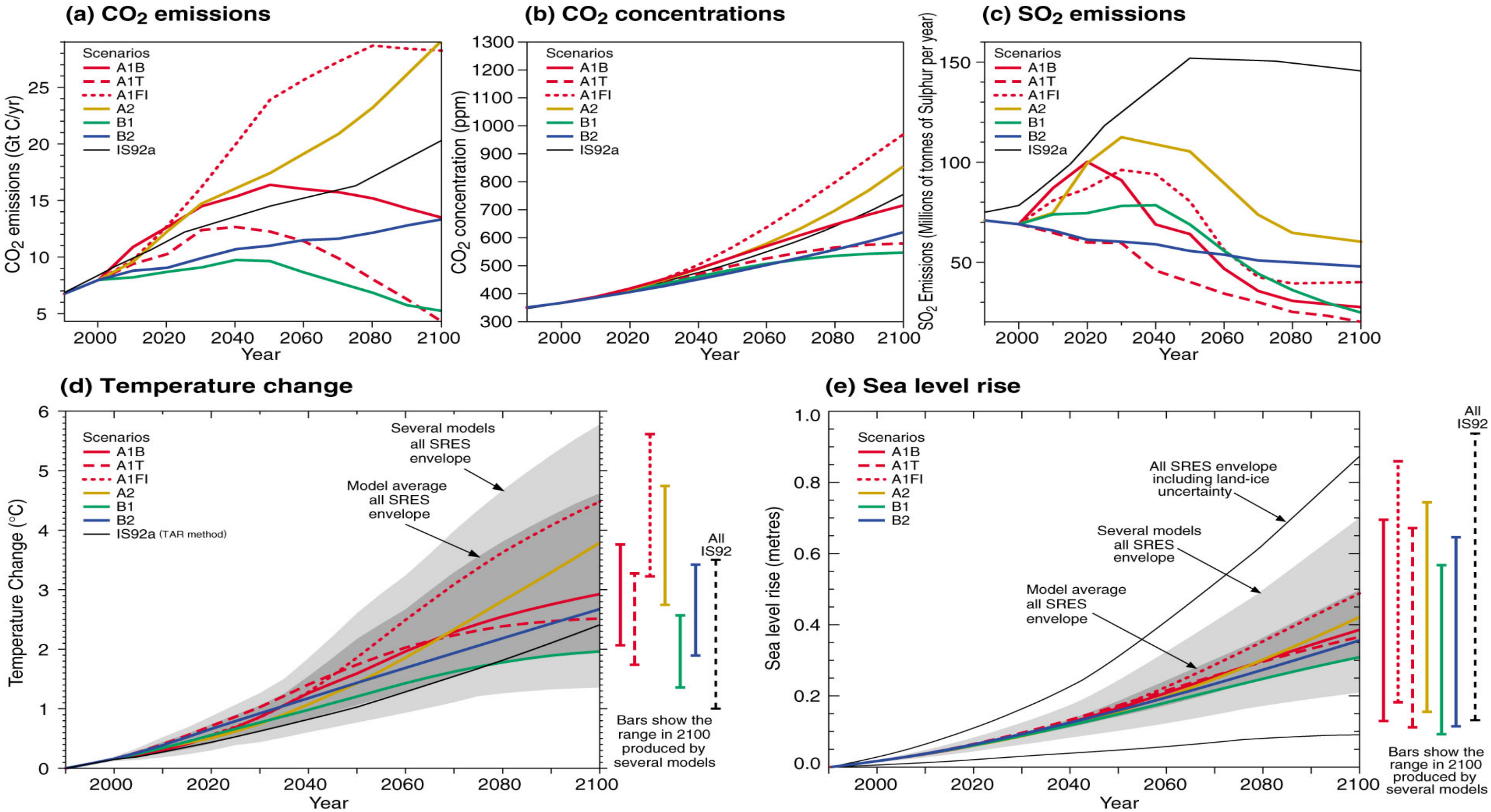
Glacier Mass Balance



Predicting Future Climate Change

The Global Climate of the 21st Century

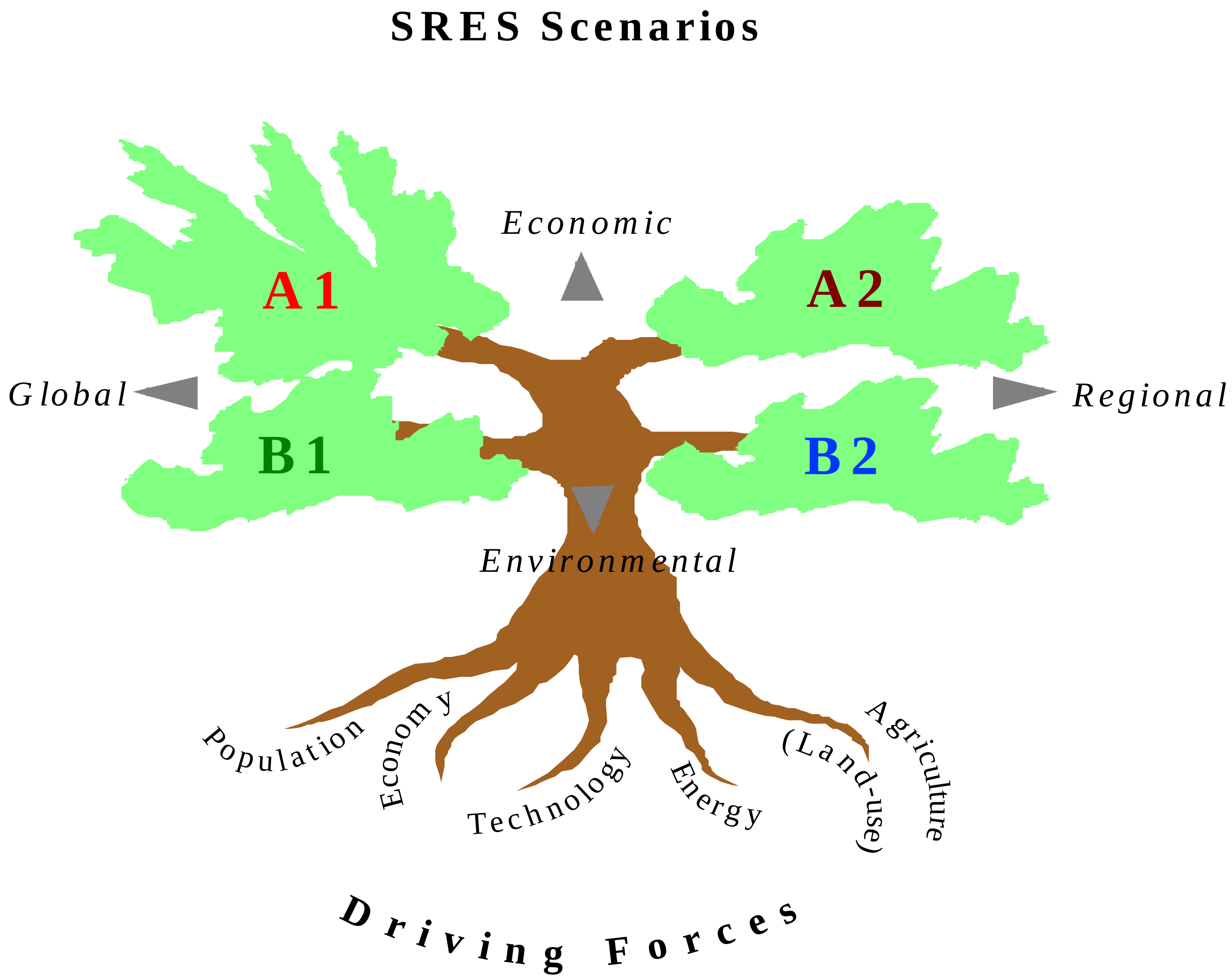
GHG conc. 2-3 times pre-ind. level (280 ppmv) by 2100



Temp. rise ~3C (1.8 to 4) by 2100

Sea level rise ~0.4m (0.2 to 0.6) by 2100

IPCC-SRES scenarios of world development



Future Global Scenario Assumptions

	1990	2100
• Population (billion)	5.3	7.0 - 15.1
• World GDP (10^{12} 1990US$/yr)	21	235 - 550
• Per capita income ratio: developed countries to developing countries	16.1	1.5 - 4.2
• Final energy intensity (10^{6}J/US$)[a]	16.7	1.4 - 5.9
• Primary energy (10^{18} J/US$)	351	514 - 2226
• Share of coal in primary energy (%)[a]	24	1 - 53
• Share of zero carbon in primary energy (%)[a]	18	28 - 35

Green Highlights – ideas for statisticians to pursue further

Data Needs for Better Scenarios

- **Internal consistency of variables**
- **Probability of a given scenario**

Why CC is important for SD

Key Motivations for Seeking More Sustainable Development Paths

Motivation 1: Sustainable Development will be set back by Climate Change - developing countries most vulnerable

The sustainable development challenge is to:

- **alleviate poverty** for the 1.3 billion people who live on less than $1 per day and the 3 billion people who live on less than $2 per day
- provide adequate **food**, especially for the 800 million people who are malnourished today—this will require food production to double in the next 35 years without further environmental degradation, e.g., deforestation
- provide **clean water** for the 1.3 billion people who live without clean water and provide sanitation for the 2 billion people who live without sanitation
- provide **energy** for the 2 billion people who live without electricity
- provide a **healthy environment** for the 1.4 billion people who are exposed to dangerous levels of *outdoor pollution* and the even larger number exposed to dangerous levels of *indoor air pollution and vector-borne diseases*
- provide **safe shelter** for those that live in areas susceptible to civil strife due to environmental degradation and those vulnerable to natural disasters

Motivation 2:
CC & SD Major agreements: Poverty/Equity focus

1. UNCED 1992: Rio Earth Summit

- Rio Declaration of Principles
- Agenda 21
- UNFCCC

2. Millennium Development Goals 2000: UN

3. WSSD Goals 2002: Johannesburg Summit

4. Millennium Development Summit 2006: UN

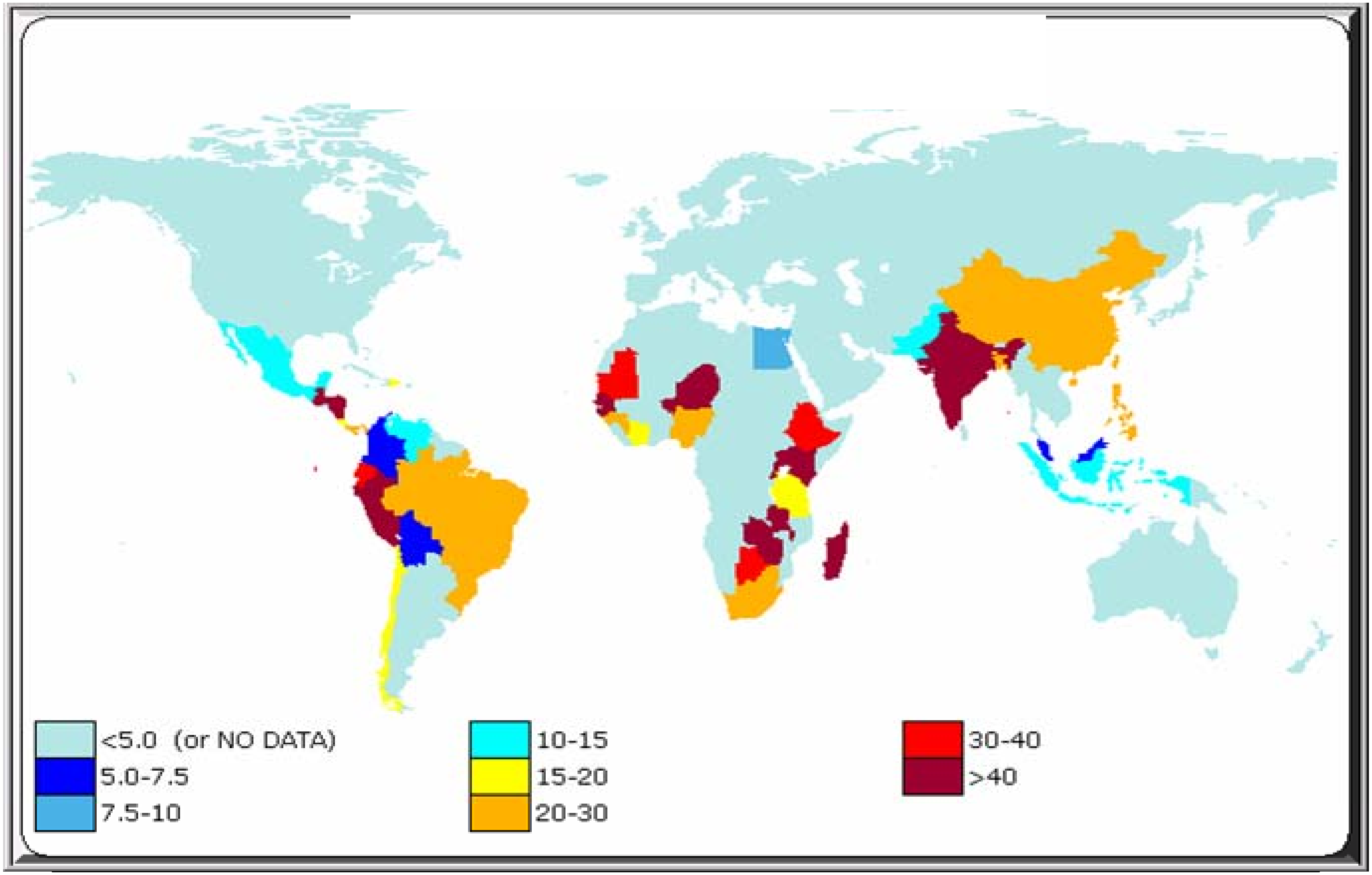
Millennium Development Goals (MDG)

United Nations Millennium Declaration, 2000

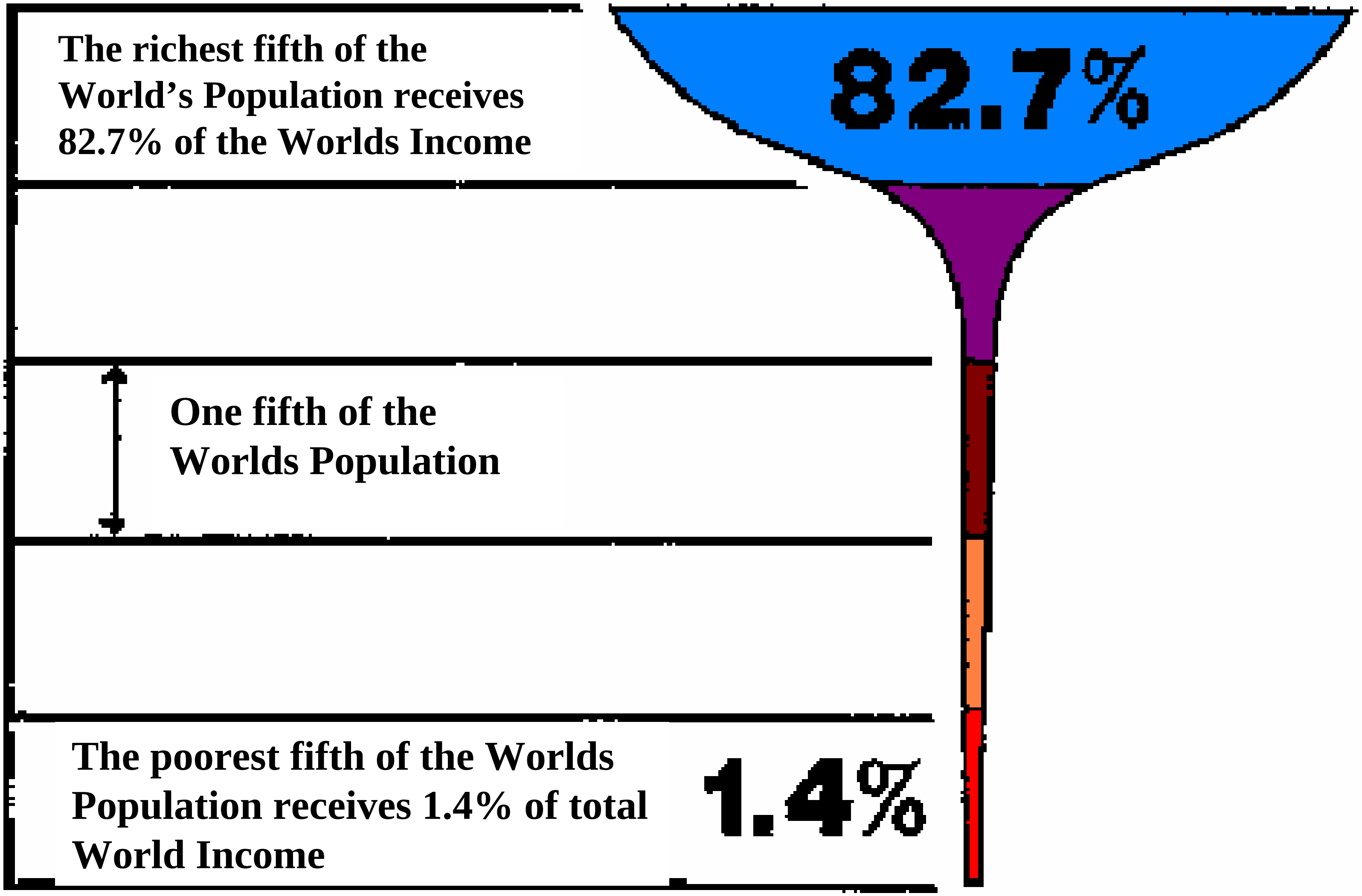
- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empowerment
- Reduce child mortality
- Improve maternal health
- Combat HIV/AIDS, malaria and other diseases
- Ensure environmental sustainability
- Develop a global partnership for development

Commendable targets, but will they be met?

Poor living on < $1 per day



Inequitable World Income Distribution: Champagne Glass



Motivation 3:
UN Framework Convention on Climate Change 1992

Article 2

Stabilize atmospheric GHG concentrations to prevent 'dangerous' anthropogenic inteference in the climate system:

• enable **economic development** to proceed in a sustainable manner

• ensure **food production** is not threatened

• allow **ecosystems** to adapt naturally

UNFCCC speaks specifically of **"common but differentiated responsibilities"**

Policy Priorities will drive data needs

UNFCCC speaks specifically of **"common but differentiated responsibilities"**

Relative Priorities:

- **Non-Annex I : Vulnerability/Impacts/Adaptation**
- **Annex I : Mitigation/Emissions**

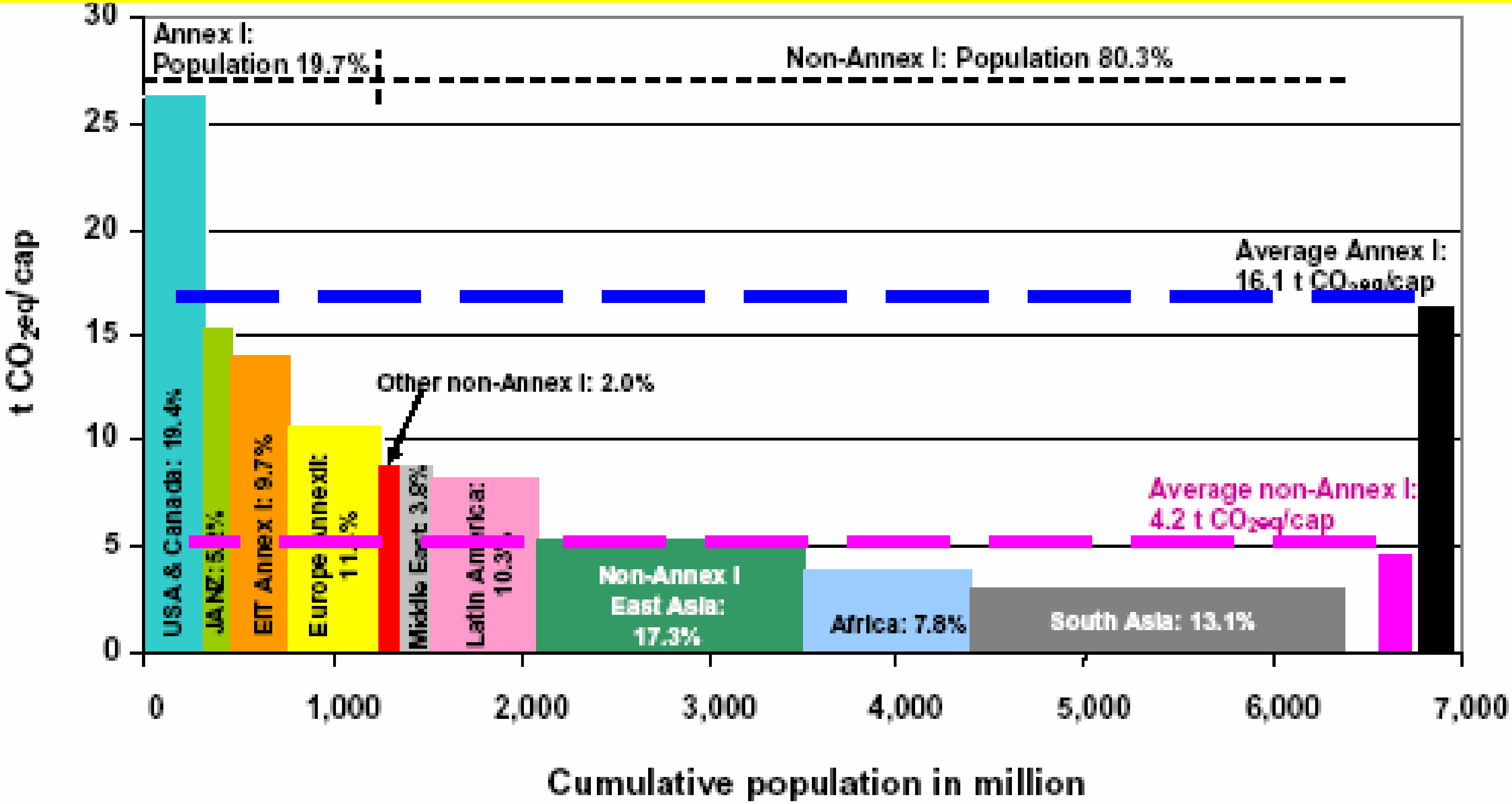
Adaptation Burden & Equity: CC → SD

Vulnerability/Impacts/Adaptation is first priority of developing countries that are most threatened by climate change

- **Climate change is likely to impact disproportionately upon the poorest countries and the poorest persons within all countries,** exacerbating inequities in health status and access to adequate food, clean water and other resources.
- **Net economic effects will be negative in most developing countries**
- **Impacts will be worse** - many areas are already flood and drought prone, and economic sectors are climate sensitive
- **Lower capacity to adapt** because of a lack of financial, institutional and technological capacity, and access to knowledge

Mitigation Responsibility & Equity: SD ⟶ CC

Mitigation is main responsibility of industrial countries with high per capita GHG emissions



MIND

Munasinghe Institute for Development

Motivation 4:

Global Long Term Perspectives

- Lessons of History
- Future Scenarios

Sustainability & Resource Use: Historical view

DURABLE USE OF RESOURCES

- Nile Basin (Egypt)

  Pharaonic system lasted over 4000 years, with sustainable resource use and reasonable quality of life

- Yellow River Basin (China)

  Imperial system was stable for many millenia, and supported flourishing society

- Saraswati River (India)

  Hosted a flourishing civilisation for 4000 years. River eventually dried up due to tectonic activity, climate change and desertification, and water piracy.

OVEREXPLOITATION OF RESOURCES

- Sahara Desert

  Once green with many animals and hunters. Over-exploitation led to a drier habitat which could no longer sustain these populations

Barbarization

Unrestrained market forces increase risk of conflict (erosion of ethical & moral underpinnings of civilization)

Climate Change
Poverty, Inequity
Environmental degradation
Social polarization
Terrorism

Chaos, Break-down
Conflict, rivalry and competition for resources overwhelm all efforts to impose order

Fortress World

Local, regional and international groups respond selfishly to protect their interests

Influences Underlying Modern Development

- **Economic forces like world trade and comparative advantage in production**

- **Environmental and geographic factors including natural resource availability**

- **Social and institutional aspects including behavioural norms, values and governance**

In practice all the above three elements have shaped and will continue to shape development.

Climate change will affect and be affected by all three.

A Long Term Vision of Sustainable Development

Levels	Indicators	Time	Human Interventions
Main Issues	Poverty, Inequity, Exclusion, Conflict, Environmental Harm (including Climate Change)	Now	High risk of unrestrained market forces at work ("Washington consensus", globalisation etc.) – Reactive BAU: mainly govt.
Immediate Drivers	Consumption Patterns Population Technology Governance	Transition	Making development more sustainable (MDMS) with systematic policy reform to manage market forces (Sustainomics) – Proactive: partnerships - govt., business, civil soc.
Underlying Pressures	Basic Needs Social Power Structure Values, Perceptions, Choices Knowledge Base	Long Term	Fundamental global sustainable dev. transition catalysed through grass roots citizens movements, driven by social justice and equity concerns, innovative leadership, policies, tech. (new SD paradigm) – Proactive: civil soc., govt., business

Source: Munasinghe (2007), IPCC, MA, GTI

Global Responses to the Climate Change Challenge

- **Mitigation**
- **Adaptation**

MOST DESIRABLE:

CC Policies that Combine Both Adaptation and Mitigation (Win-Win) and also Make Development More Sustainable (MDMS)

The Challenge of Mitigation

UNFCCC 1992 – good start. Article 2 specifies stabilization of atmospheric concentrations of GHG concentrations at a level that does not harm the climate system (food security, ecological systems and sustainable economic development).

Kyoto Protocol 1997 – modest target. Annex I countries reduce emissions by 5% relative to 1990, by 2012.

Post-Kyoto Agreement 2012? – Bali road map 2007 is a start. But Parties could agree only on agenda and timetable (NOT even preliminary targets).

Mitigation: Kyoto Protocol (1997) in force in 2005 (without US)

1. **Annex 1 Countries undertake mitigation -- GHG emission reductions (2008-2112) relative to 1990:**

EU	- 8 %
USA	- 7 %
Japan	- 6 %
Australia	+ 8 %
Russian Federation	0 %

all developed countries - 5 %

2. **No obligations for developing countries and economies in transition**

3. **Kyoto Mechanisms: CDM, JI, emissions trading**

Disturbing Near Term Trends in GHG Emissions: 1970-2030

During 1970-2004 (Actual)

GHG emissions covered by the Kyoto Protocol have increased by about 70%.

CO_2 (77% of GHG), has grown by about 80%.

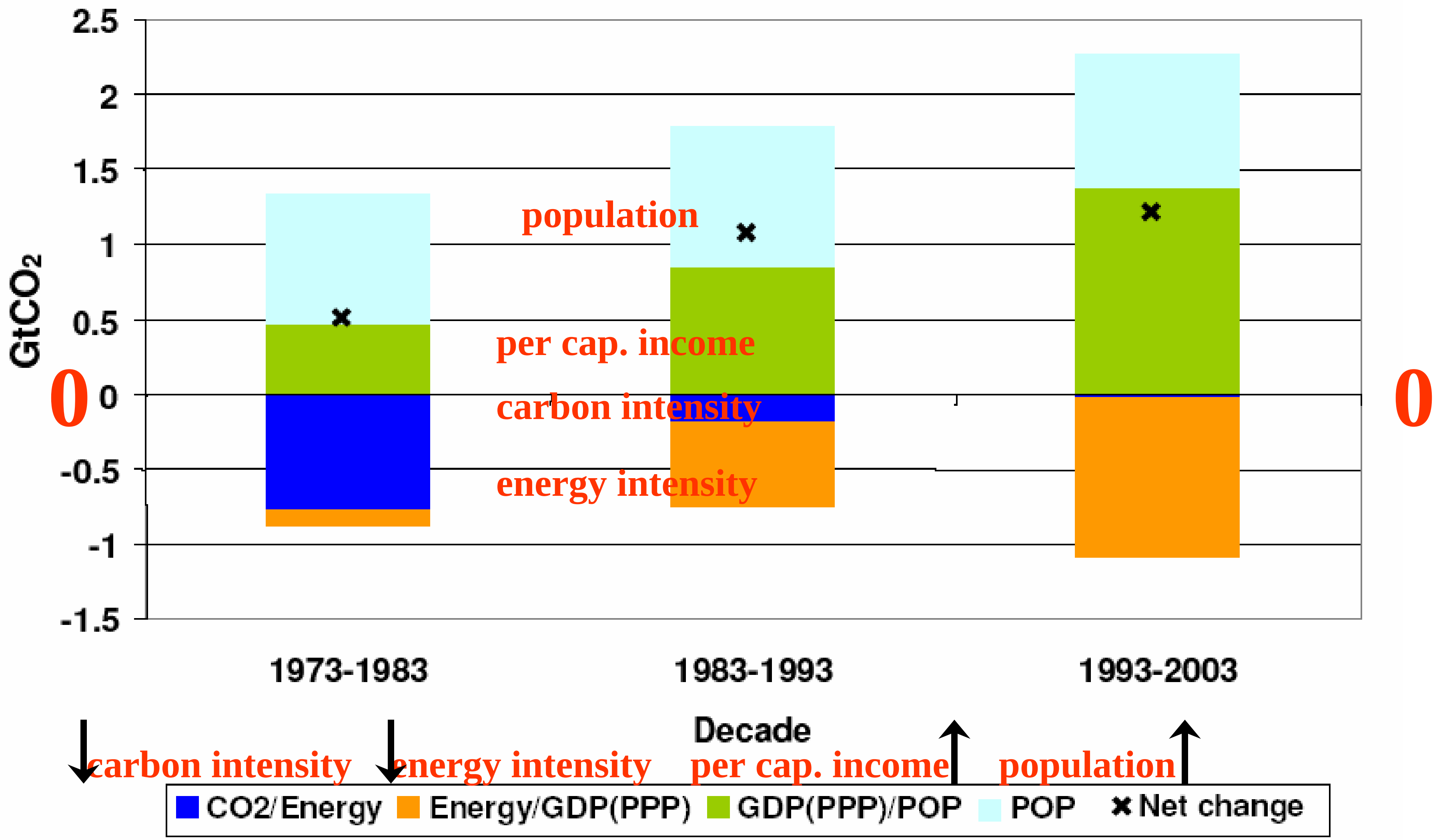
Even after Kyoto 1997, emissions have continued to increase

During 2000-2030 (projected)

GHG emission will rise 45-110% with current policies. Two thirds of this growth will be in developing countries, but per capita emissions in developed countries will remain 3-4 times higher.

Global CO2 Emissions Breakdown – Drivers (1973-2003)

$CO2 = [CO2/Energy] \times [Energy/GDP] \times [GDP/Pop] \times Pop.$



M I N D

Munasinghe Institute for Development

Concentrations, mean temp. rise & peak year emissions

The lower the stabilization level, the more quickly emissions would need to peak and to decline thereafter. EU danger limit = 2°C

Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels.

CO_2 stabili-zation	CO2-Equivalent Stabili-zation level	Year CO2 needs to peak	GDP reduction in 2030	Reduction in 2050 relative to 2000	Global Mean temp. incr. at equilib.	Global average sea level rise from thermal expansion
ppm	ppm	Year	%	Percent	°C	metres
350 – 400	445 – 490	2000 – 2015	< 3	-85 to -50	2.0 – 2.4	0.4 – 1.4
400 – 440	490 – 535	2000 – 2020	< 2	-60 to -30	2.4 – 2.8	0.5 – 1.7
440 – 485	535 – 590	2010 – 2030	0.6	-30 to +5	2.8 – 3.2	0.6 – 1.9
485 – 570	590 – 710	2020 – 2060	0.2	+10 to +60	3.2 – 4.0	0.6 – 2.4
570 – 660	710 – 855	2050 – 2080		+25 to +85	4.0 – 4.9	0.8 – 2.9
660 – 790	855 – 1130	2060 – 2090		+90 to +140	4.9 – 6.1	1.0 – 3.7

GHG Mitigation Costs: 2030 and 2050

1. GDP reduction costs

Stabilisation levels (ppm CO_2-eq)	Median GDP reduction [a] (%)		Range of GDP reduction [b] (%)		Reduction of average annual GDP growth rates (percentage points) [c], [e]	
	2030	2050	2030	2050	2030	2050
445 – 535 [d]	Not available		< 3	< 5.5	< 0.12	< 0.12
535 – 590	0.6	1.3	0.2 to 2.5	slightly negative to 4	< 0.1	< 0.1
590 – 710	0.2	0.5	-0.6 to 1.2	-1 to 2	< 0.06	< 0.05

2. Costs per tonne of CO_2equivalent mitigated

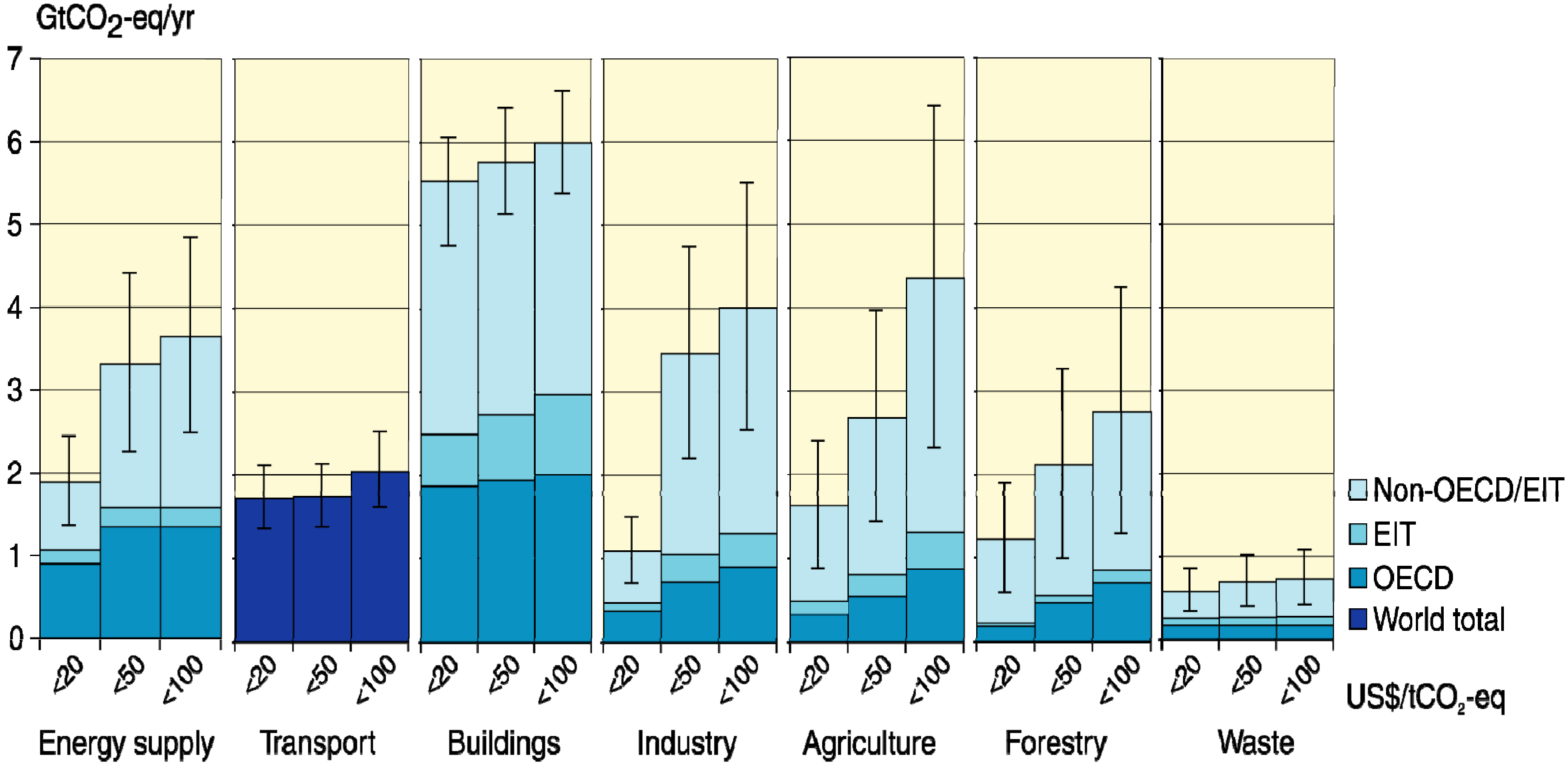
To achieve a 2100 target of 550 ppmv, the costs in 2030 will be US$ 20-80 per tonne mitigated. These costs could fall further to US$ 5-65 with induced technological advanced.

Long-term stabilization (2100 and beyond) of GHGs concentrations is possible with SD

- Known technological options could achieve stabilization of carbon dioxide at levels of 450-550 ppm over the next 100 years
- Technology development and diffusion are important components of cost-effective stabilization
- The SD pathway to stabilization and the stabilization level itself are key determinants of mitigation costs

Mitigation Potential: all sectors and regions can contribute

Better Data is Needed



total sectoral potential at <US$100/$CO_2$-eq in $GtCO_2$-eq/yr:

Energy supply	Transport	Buildings	Industry	Agriculture	Forestry	Waste
2.4-4.7	1.6-2.5	5.3-6.7	2.5-5.5	2.3-6.4	1.3-4.2	0.4-1

Note: estimates do not include non-technical options, such as lifestyle changes.

How can emissions be reduced?

Sector	(Selected) Key mitigation technologies and practices currently commercially available.
Energy Supply	efficiency; fuel switching; nuclear power; renewable (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of CO_2 Capture and Storage
Transport	More fuel efficient vehicles; hybrid vehicles; biofuels; modal shifts from road transport to rail and public transport systems; cycling, walking; land-use planning
Buildings	Efficient lighting; efficient appliances and airco; improved insulation ; solar heating and cooling; alternatives for fluorinated gases in insulation and aplliances

How can emissions be reduced?

Sector	(Selected) Key mitigation technologies and practices currently commercially available.
Industry	More efficient electrical equipment; heat and power recovery; material recycling; control of non-CO_2 gas emissions
Agriculture	Land management to increase soil carbon storage; restoration of degraded lands; improved rice cultivation techniques; improved nitrogen fertilizer application; dedicated energy crops
Forests	Afforestation; reforestation; forest management; reduced deforestation; use of forestry products for bioenergy
Waste	Landfill methane recovery; waste incineration with energy recovery; composting; recycling and waste minimization

Selected sectoral policies, measures and instruments that have shown to be environmentally effective

Sector	Policies , measures and instruments shown to be environmentally effective	Key constraints or opportunities
Energy supply	Reduction of fossil fuel subsidies	Resistance by vested interests may make them difficult to implement
	Taxes or carbon charges on fossil fuels	
	Feed-in tariffs for renewable energy technologies	May be appropriate to create markets for low emissions technologies
	Renewable energy obligations	
	Producer subsidies	

[1] Public RD&D investment in low emission technologies have proven to be effective in all sectors.

Selected sectoral policies, measures and instruments that have shown to be environmentally effective

Sector	**Policies[1], measures and instruments shown to be environmentally effective**	**Key constraints or opportunities**
Transport	Mandatory fuel economy, biofuel blending and CO_2 standards for road transport	Partial coverage of vehicle fleet may limit effectiveness
	Taxes on vehicle purchase, registration, use and motor fuels, road and parking pricing	Effectiveness may drop with higher incomes
	Influence mobility needs through land use regulations, and infrastructure planning	Particularly appropriate for countries that are building up their transportation systems
	Investment in attractive public transport facilities and non-motorised forms of transport	

[1] Public RD&D investment in low emission technologies have proven to be effective in all sectors.

Sustainable development paths will facilitate climate change mitigation

- Making development more sustainable by changing development paths can make a major contribution to climate change mitigation
- Macroeconomic policy, agricultural policy, multilateral development bank lending, insurance practices, electricity market reform, energy security policy and forest conservation can significantly reduce emissions.
- Implementation may require resources to overcome multiple barriers.
- Possibilities to choose and implement mitigation options to realise synergies and avoid conflicts with other dimensions of sustainable development.

Technologies and policies exist to reduce near term (2010-2020) GHG emissions: Energy and Land Use offer best potential

- **Energy:** significant technical progress has been made in the last 5 years and at a faster rate than expected (wind turbines, elimination of industrial by-products, hybrid engine cars, fuel cell technology, underground carbon dioxide storage)
- **Land Use:** good potential for carbon sinks and reduced GHG emissions from both better management of existing land cover, and transformation of land use

Status/Availability of Data on GHG Emissions (evidence from IPCC work on GHG inventories)

Country Group	Energy Emissions	Land Use Emissions
Non-Annex I	OK	Worst
Annex I	Best	Poor

Key Policy Elements

- **Policies for "carbon price"-** can create incentives for producers and consumers to significantly invest in low-GHG products, technologies and processes. Higher carbon prices could impose significant burdens on the poor, unless targetted relief policies are implemented to ensure basic energy needs are met.
- **Technology Policies** - Deployment of low-GHG emission technologies and RD&D would be required for achieving stabilization targets and cost reduction
- **International Agreements** - achieving the UNFCCC/Kyoto Protocol targets may stimulate a global response to the climate problem, an array of national policies, the creation of an international carbon market and new institutional mechanisms. Future agreements will help reduce global costs of mitigation(eg: emission trading, Joint Implementation and CDM) and improve environmental effectiveness

Mitigation Data for Policy

Dissaggregate emissions data needed for:

- **Allocation of emissions rights and mitigation burdens (between and within countries)**
- **Identifying, implementing and enforcing most the effective and sustainable mitigation options**
- **Building mitigative capacity**

Global Adaptation

Response Options

Most Vulnerable People

Children

Elderly

Poor

Most Vulnerable Regions

Most Vulnerable Systems and Sectors

- Some ecosystems:
  - Coral reefs; sea-ice regions
  - Tundra, boreal forests, mountain and Mediterranean regions
- Low-lying coasts, mangroves & salt marshes
- Water resources in mid-latitudes & dry Tropics
- Low-latitude agriculture
- Human health where adaptive capacity is low

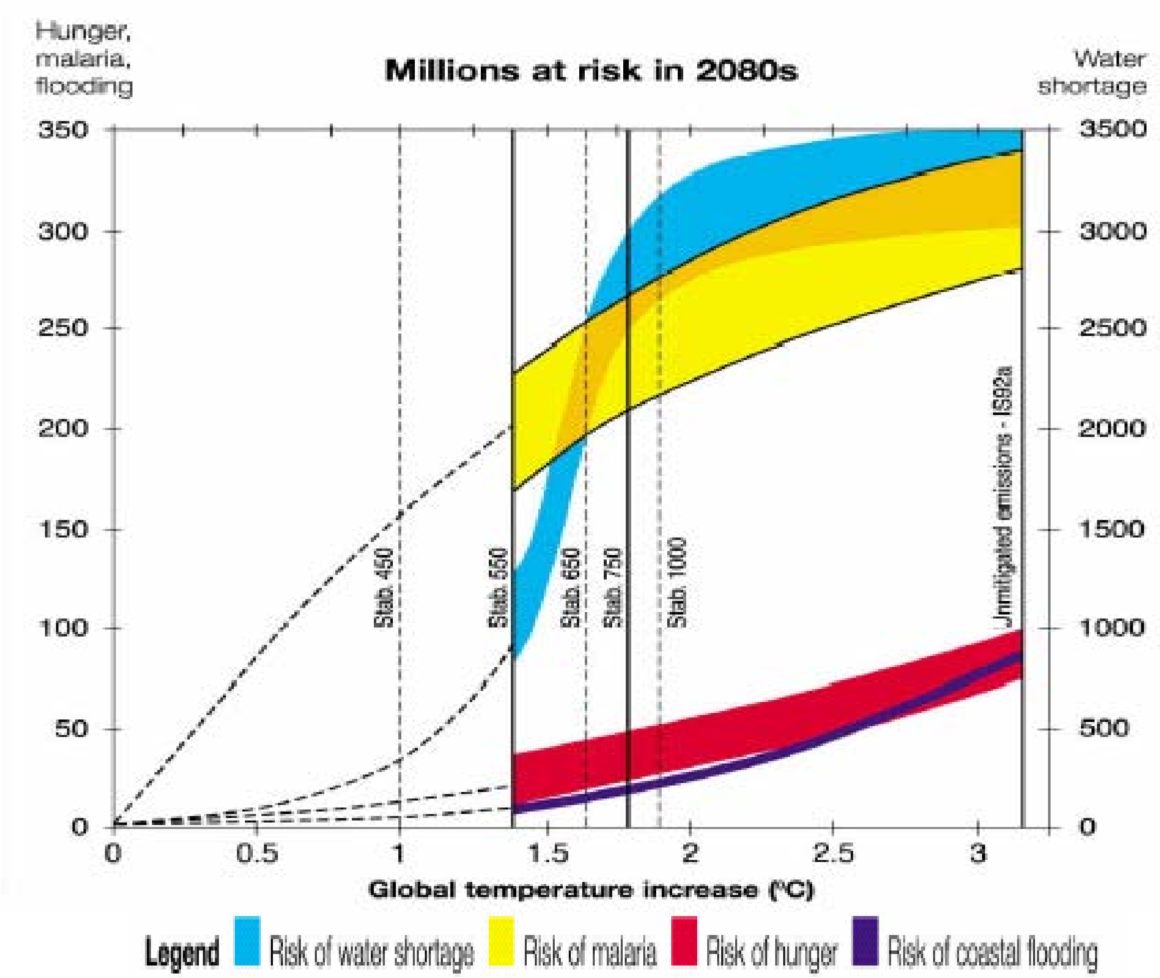
Main impacts on Systems & Sectors: 1

- **Water**
  - increase in number of very wet and very dry areas
  - Saltwater intrusion in coastal areas, salinisation of groundwater
  - Increasing water stress
- **Ecosystems**
  - Some biodiversity loss
  - Forest expansion in northern areas
  - Increased wild fires
  - Loss of corals due to bleaching
  - Oceanic biotic move polewards
- **Food, Fibre and Forest Products**
  - Small beneficial impacts on crops in temperate regions
  - Poleward spread of diseases and pests
  - Warming will decrease livestock productivity
  - Increase in global forest product output
  - Changes in distribution and productivity of fish species

Main impacts on Systems & Sectors: 2

- **Coastal Systems and Low-Lying Areas**
  - **Greatest vulnerability expected along coastal strips of S. and S.E. Asia & urbanized coastal areas of Africa**
  - **Sea level rise impacts and costs are greater in developing countries**
- **Industry, Settlements, and Society**
  - **Vulnerability higher in those areas which rely on climate sensitive resources**
  - **Increase in cost of insurance cover**
- **Health**
  - **Increased mortality mainly from increased vector-borne and diarrheal diseases**
  - **Increases heat related health problems**

Hundreds of Millions at Risk by 2080 –
Malaria, Hunger, Water Shortage and Flooding
Note: EU Risk Threshold is 2 degrees C



Extreme Events

- *Very likely* that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent

- *Likely* that future tropical cyclones will become more intense, with larger peak wind speeds and more heavy precipitation
  - **less confidence in decrease of total number**

- Extra-tropical storm tracks projected to move poleward with consequent changes in wind, precipitation, and temperature patterns

Source: IPCC

Ecosystems Vulnerability

A temperature increase of 1.5°C - 2.5°C over present, would put 20% - 30% of higher plants and animals at high risk of extinction

Key IPCC Findings – A Few Beneficial Impacts

increased agricultural productivity in some mid-latitude regions (only for warming of up to a few degrees C)

increased water availability in some water-scarce regions

reduced winter mortality in mid- and high-latitudes

increase in timber supply (with well managed forests)

Potential Large Scale Impacts - Uncertain

Greenhouse gas emissions in the 21st century might set in motion large-scale, high-impact, non-linear, and potentially irreversible changes in physical and biological systems over the coming decades to millennia

- **Melting of ice sheets** (sustained warming of a few ^{o}C over millennia is projected to lead to an increase in sea level of several meters due to loss of Greenland and Antarctic Ice)
- **Thermohaline circulation**
- **Species extinction and biodiversity loss**
- **Catastrophic climate-development interactions**

Potential Benefits (damage avoided) of Adaptation and Vulnerability Reduction are large – Long term global aggregate economic damages need to be better defined

Range = US$ 3 to 95 per tonne CO_2 for 100 estimates

Large variation is due to uncertainties and deliberate choices regarding climate sensitivity, response lags, discount rates, valuing non-market impacts (including ecosystem impacts), and the treatment of inter-regional equity and catastrophic losses.

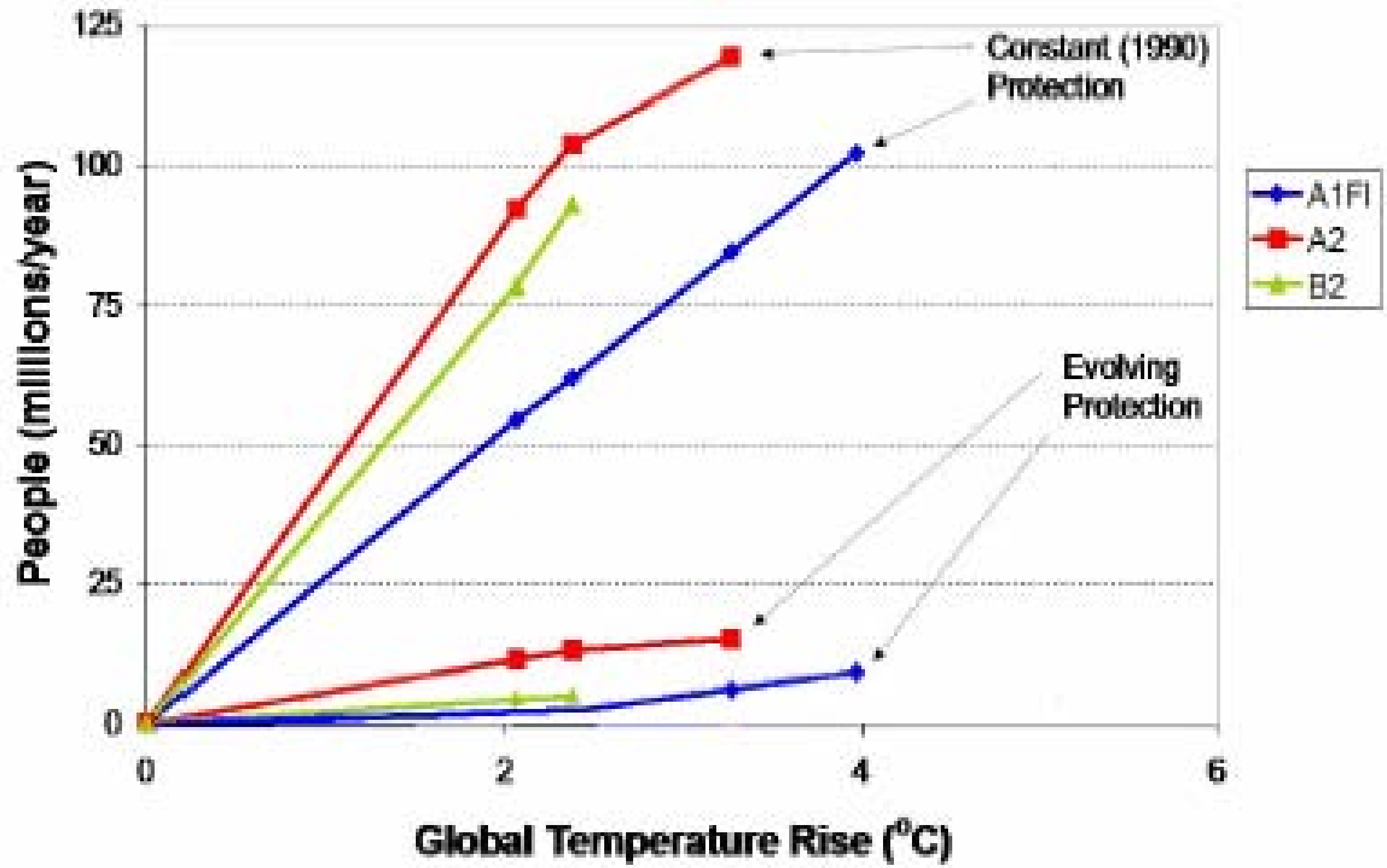
Mean value = US$ 12 per tonne CO_2 (US$ 43 per tonne C) - (present discounted net costs)

Potential Adaptive Responses Available to Human Societies

- Technological - (e.g. sea defenses, new crops)
- Behavioral – (e.g. new food and recreational choices)
- Managerial – (e.g. altered farm practices)
- Policy – (e.g. planning and regulations)

Adaptation Example: People flooded in coastal areas 2080

Evolving protection = spending increases at same rate as GDP.
Constant protection = spending maintained at 1990 levels.



MIND

Munasinghe Institute for Development

<u>Social Capital plays key role in reducing vulnerability and impacts – Civil Society is Main Source</u>

<u>Contrasting examples of Civil Society Response:</u>

2004 Tsunami - Sri Lanka

2005 Hurricane Katrina - New Orleans, USA

Data on Vulnerability/Impacts/Adaptation: Policy Priorities

Country Group	Socio-economic (human) impact	Environmental impact
Non-Annex I	Highest	Moderate
Annex I	High	High

More Specific Data Requirements

Different data and analysis needed for various purposes

- **Vulnerability assessment – risk management**
- **Impacts and costs**
- **Adaptation capacity and options**

International data needs

Global impact estimates and costs are more useful for setting global mitigation targets.

Attribution – CC vs. non-CC: Polluter Pays principle

National and sub-national data needs

Local impact assessments and adaptation options are more helpful to protect local communities and environment.

Incidence/Distribution – Who receives compensation and how much? : Victim Recompensed principle

Key IPCC Findings – Adaptation

- Adaptation is a high priority to address impacts resulting from the warming which is already unavoidable due to past emissions
- Numerous adaptation options have been identified that can reduce adverse impacts of climate change and enhance beneficial ones , but will not prevent all damages
- Greater and more rapid climate change would increase adaptation costs and pose greater challenges
- Inertia is a widespread characteristic of the interacting climate, ecological and socio-economic systems which means that large scale impacts may not be observed for decades to centuries and mal-adaptations may occur

Sustainable Development strategies can positively affect Mitigation and Adaptation

MOST DESIRABLE:

CC Policies that Combine Both Adaptation and Mitigation (Win-Win) and also Make Development More Sustainable (MDMS)

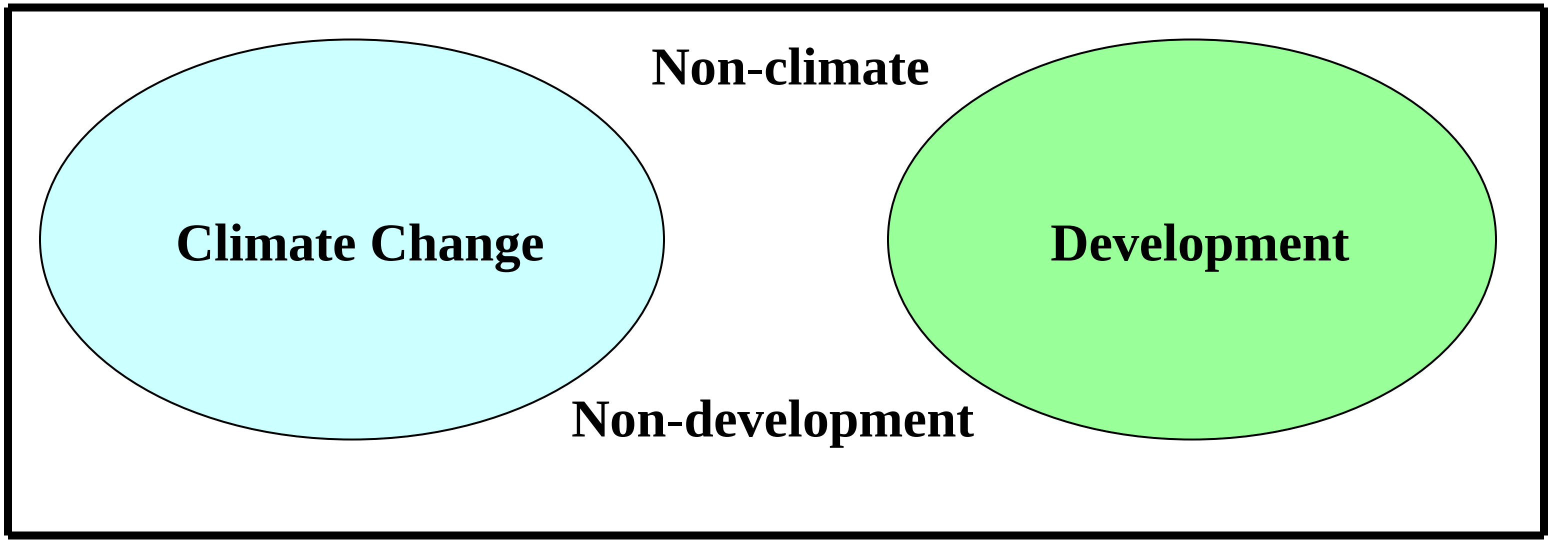
WHY ? is climate a threat to future human development

Climate Change (CC) undermines Sustainable Development (SD) and unfairly penalizes the poor

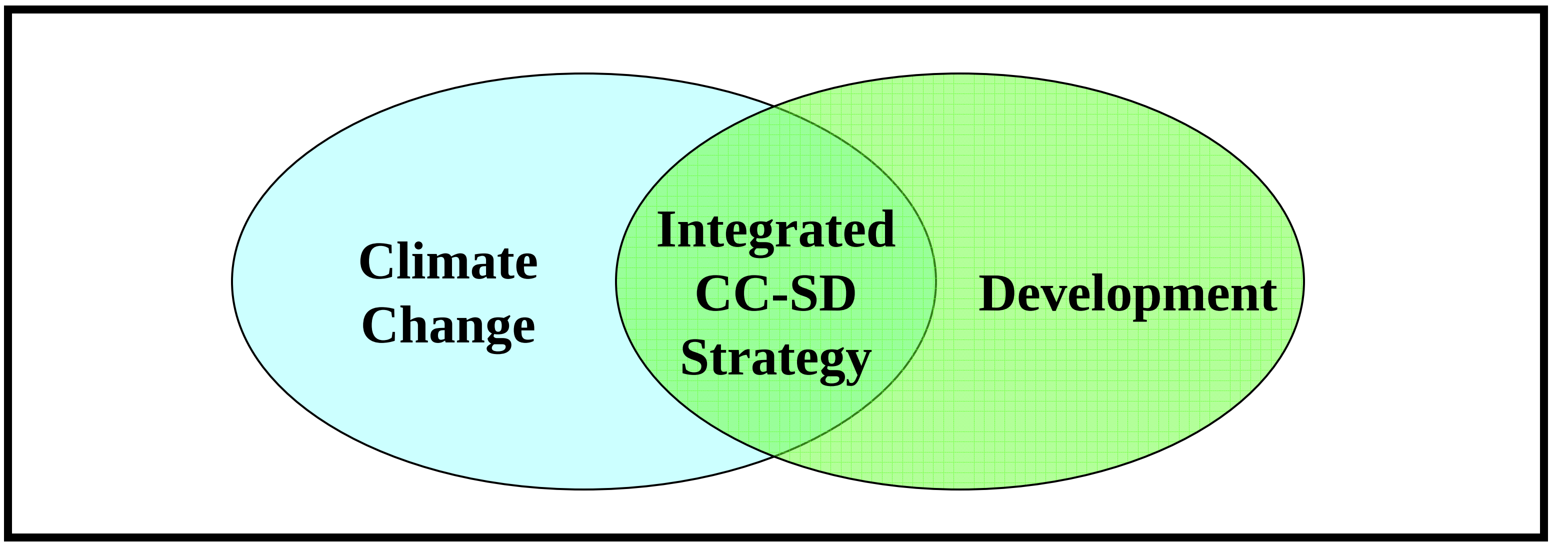
HOW ? can we better understand CC-SD links and identify specific issues

Analyze how CC affects SD and vice versa using the Sustainomics framework

Tracing the Links Between Climate Change and Sustainable Development (Sustainomics Framework)

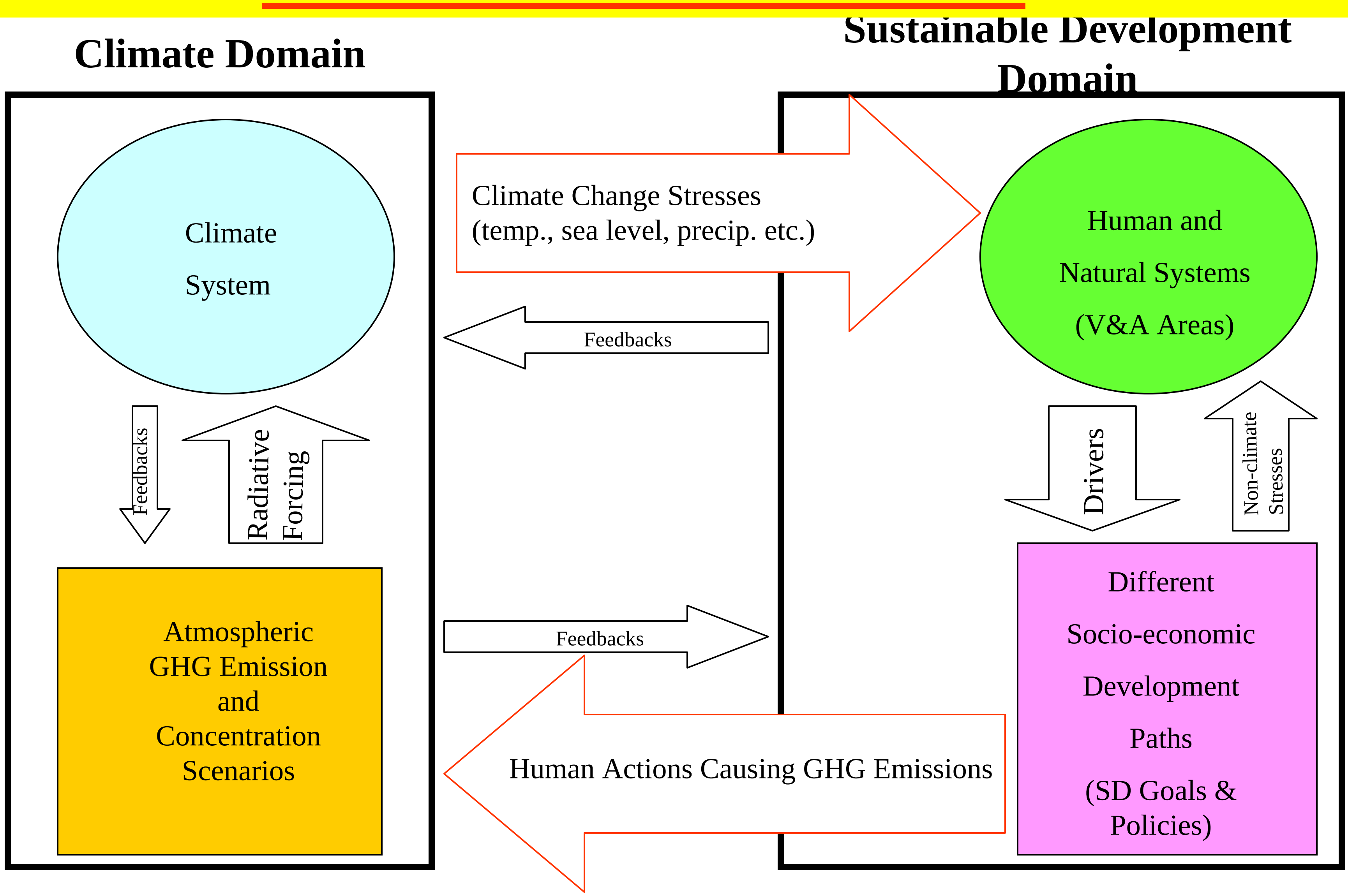


Former Viewpoint – AR1 (1990)

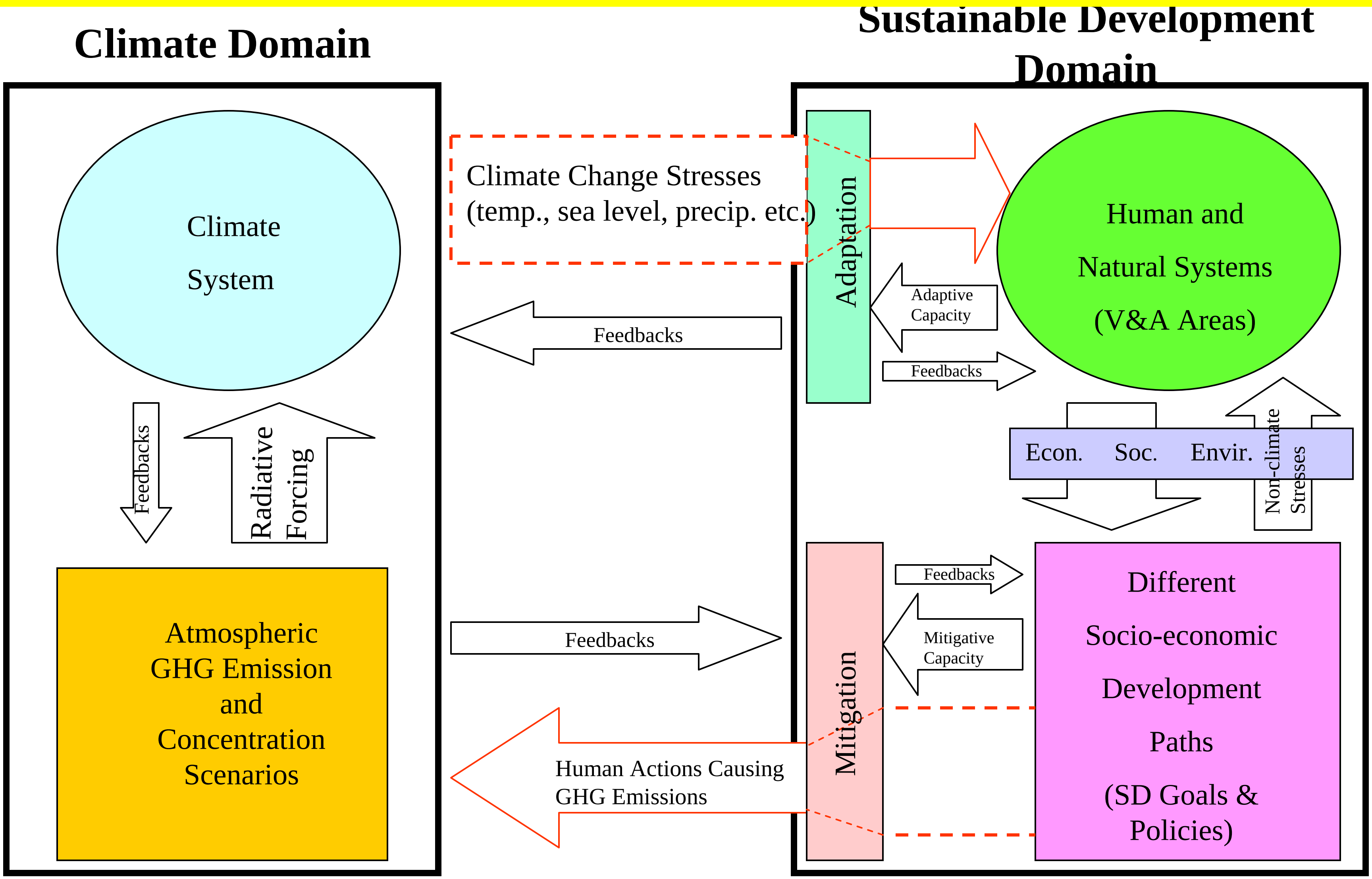


Desirable Viewpoint (policy relevant) – AR4 (2007)

Global Level CC-SD Links 1



Global Level CC-SD Links 2



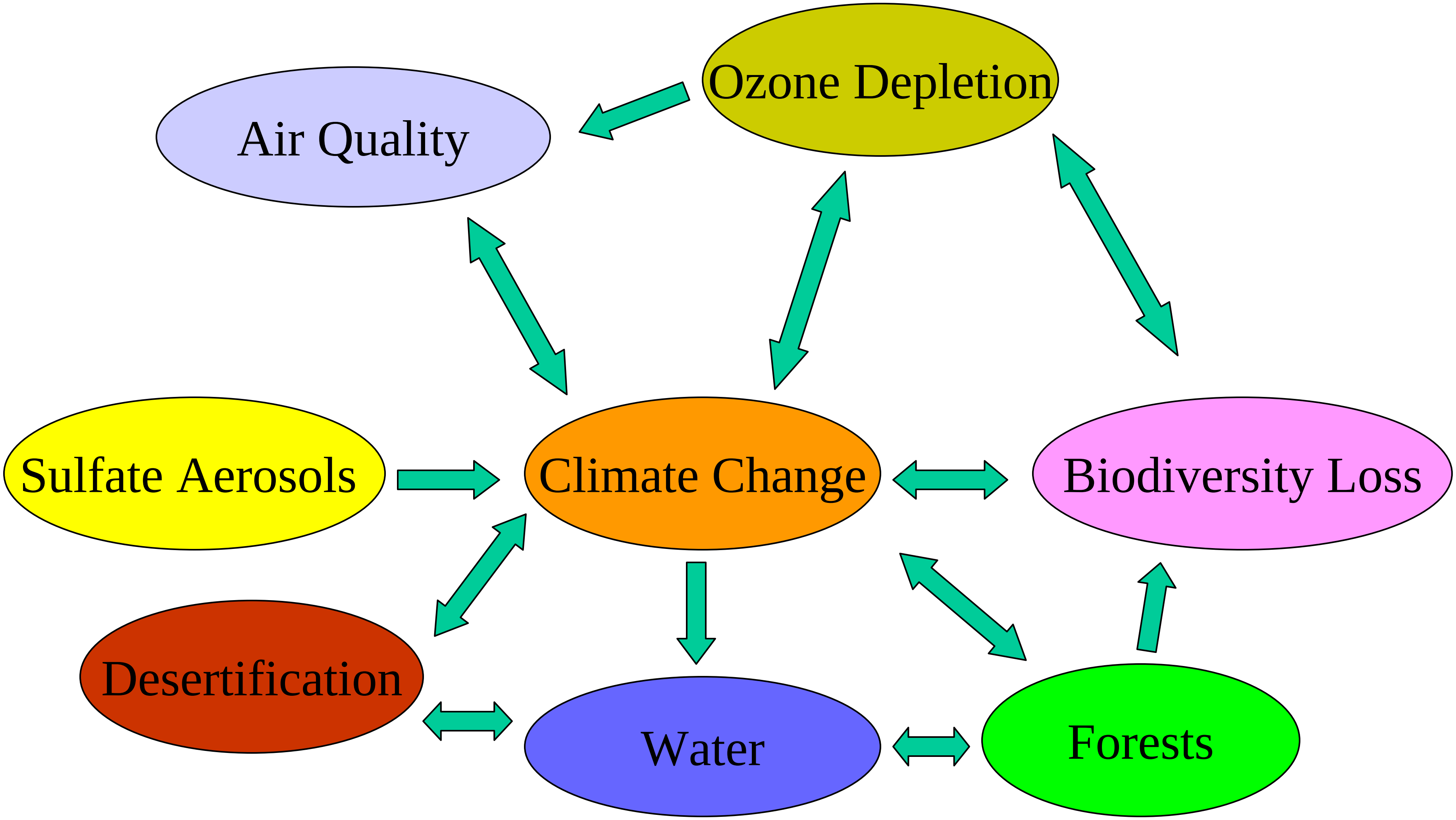
Data must help to better identify and analyze:

TWO-WAY LINKAGES BETWEEN CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

CC $\longrightarrow$ SD

CC $\longleftarrow$ SD

Further Complexity: Inter-Linkages with Other Environmental Issues



Integrating CC Policies into SD Strategy using Sustainomics

Core concepts and elements

1. Making development more sustainable (MDMS)
2. Sustainable development triangle
3. Transcending boundaries
4. Full cycle application of integrative tools – from data gathering to practical policy implementation

Understanding Sustainable Development: some (ideal) generic definitions

"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"
Source: Bruntland et al. (1987)

"process for improving the range of opportunities that will enable individual human beings and communities to achieve their aspirations and full potential over a sustained period of time, while maintaining the resilience of economic, social and environmental systems"
Source: Munasinghe (1992, Rio Earth Summit)

Practical Target:

Making Development More Sustainable (MDMS)

"An approach that will permit **sustained improvements in the quality of life** at a **lower intensity of resource use**, thereby preserving for future generations an undiminished or even **enhanced stock of productive assets** (manufactured, natural and social capital)"

Source: Munasinghe (1992), Rio Earth Summit

Rationale for approach based on Making Development More Sustainable (MDMS)

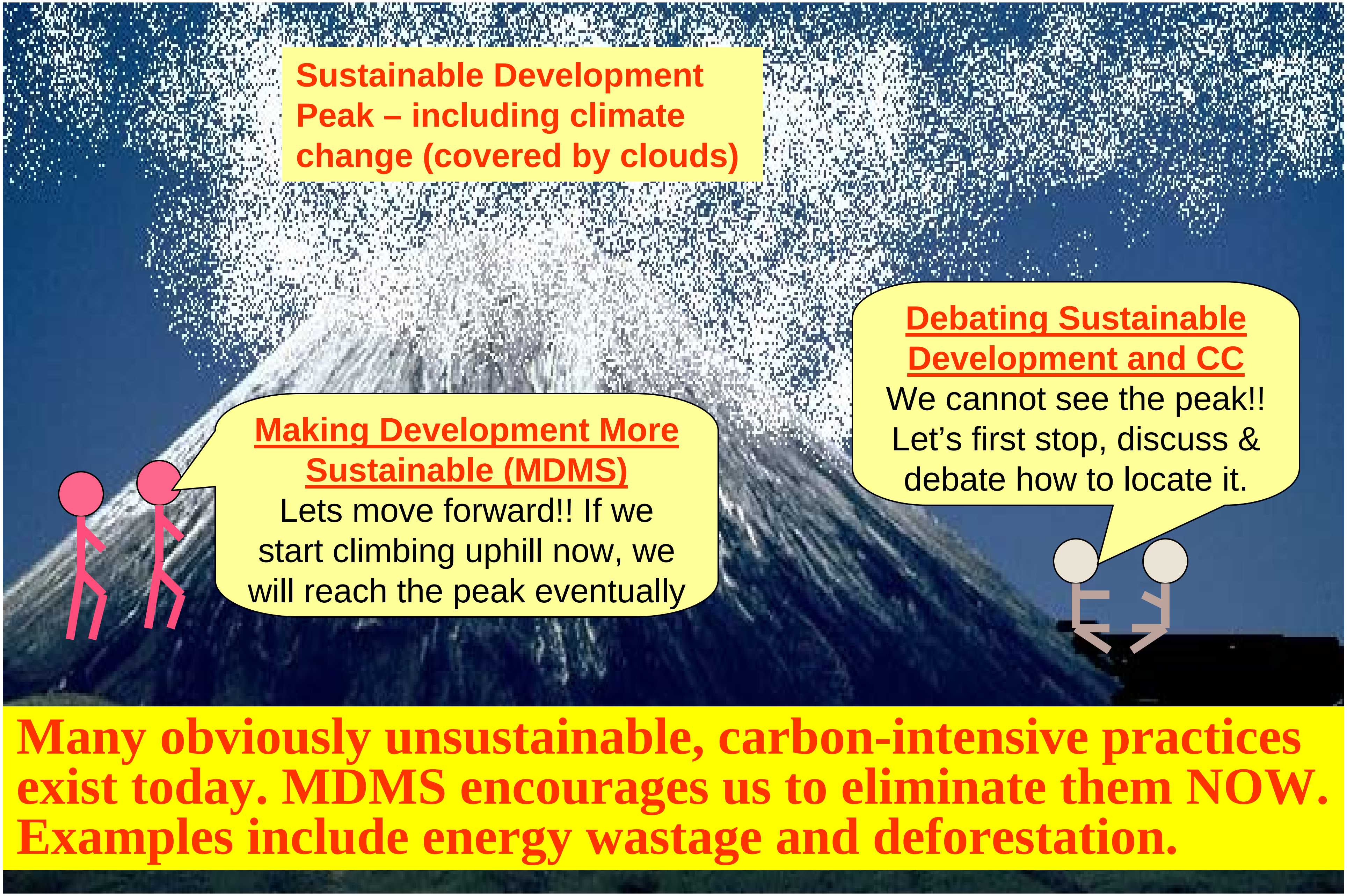
The precise definition of sustainable development remains an elusive (perhaps unreachable) goal.

Making development more sustainable (MDMS) is a less ambitious strategy based on Sustainomics, that offers greater promise.

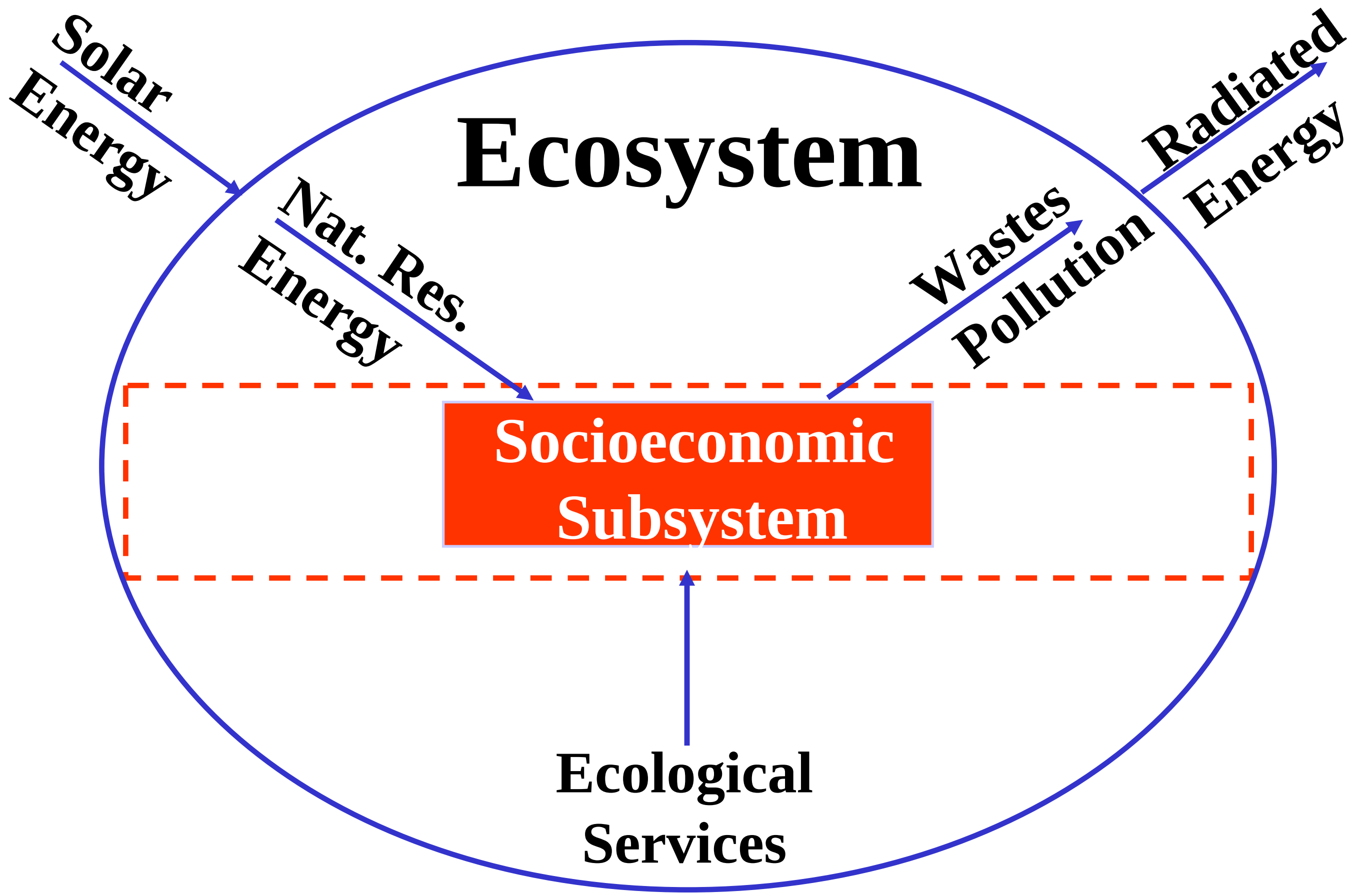
Such an incremental (or gradient-based) method is more practical, because many unsustainable activities are easier to recognize and eliminate.

Furthermore, climate response strategies cannot be expected to address all the problems of sustainable development.

Climate change impacts and response strategies could be assessed more meaningfully based on whether they "make development more (or less) sustainable". Appropriate data is needed.

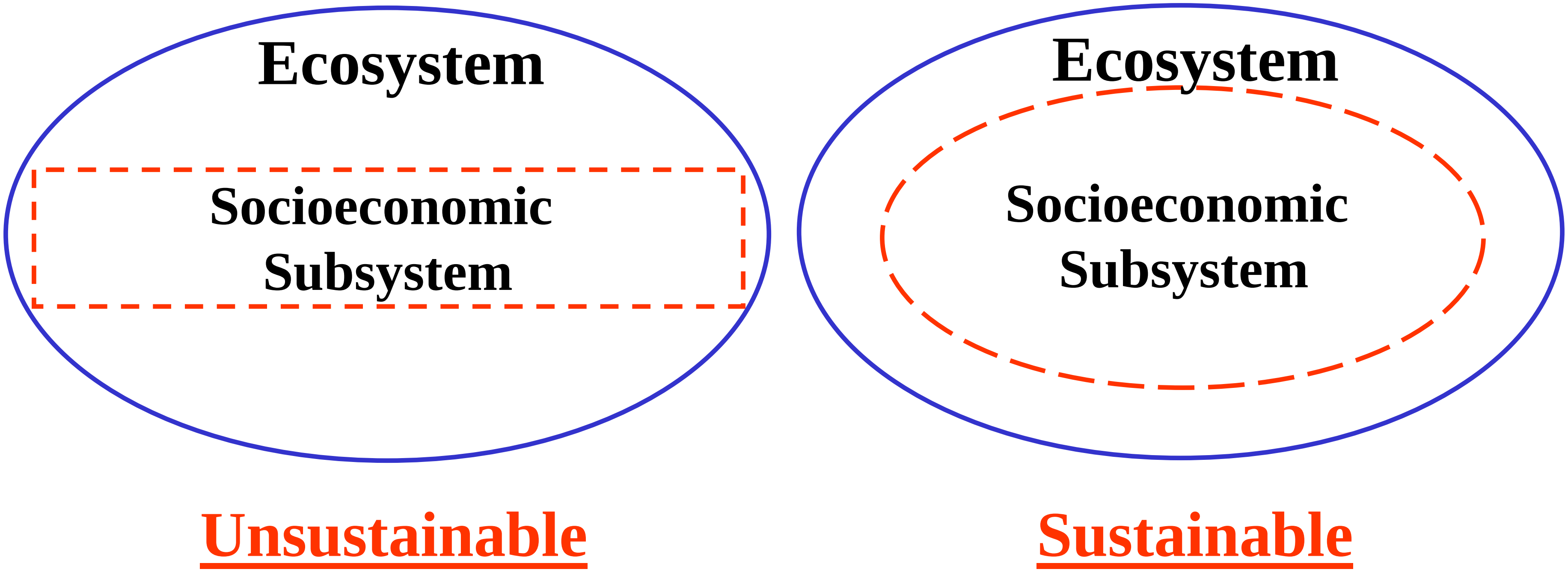

Sustainable Development Peak – including climate change (covered by clouds)
Making Development More Sustainable (MDMS)
Lets move forward!! If we start climbing uphill now, we will reach the peak eventually
Debating Sustainable Development and CC
We cannot see the peak!! Let's first stop, discuss & debate how to locate it.
Many obviously unsustainable, carbon-intensive practices exist today. MDMS encourages us to eliminate them NOW. Examples include energy wastage and deforestation.

MDMS: Restructuring development and growth I



The capacity of the ecosystem may become overloaded by the growing socio-economic subsystem (broken lines).

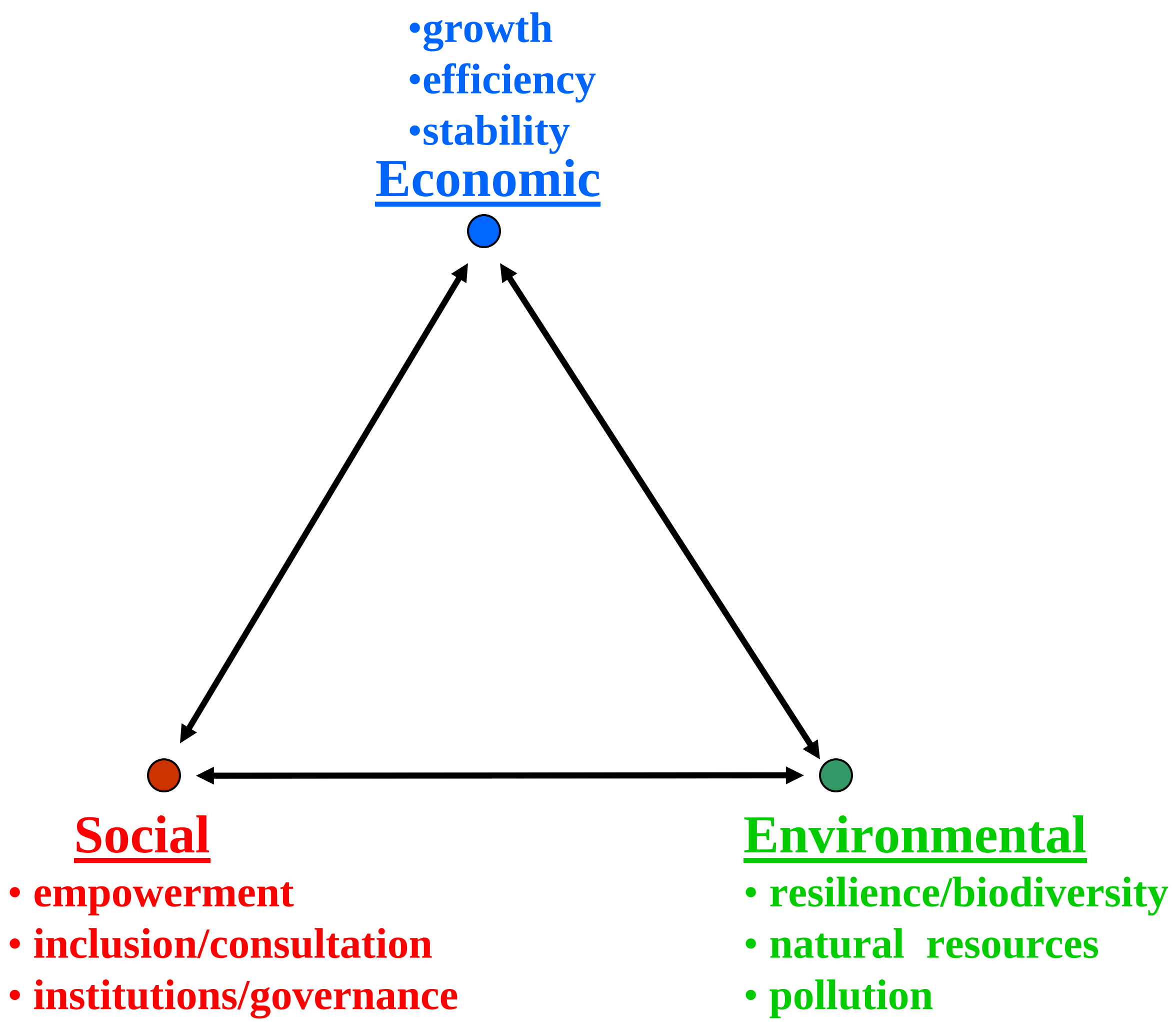
MDMS: Restructuring development and growth II (rounding the rectangle)



Integrating CC Policies into SD Strategy using Sustainomics

Core concepts and elements

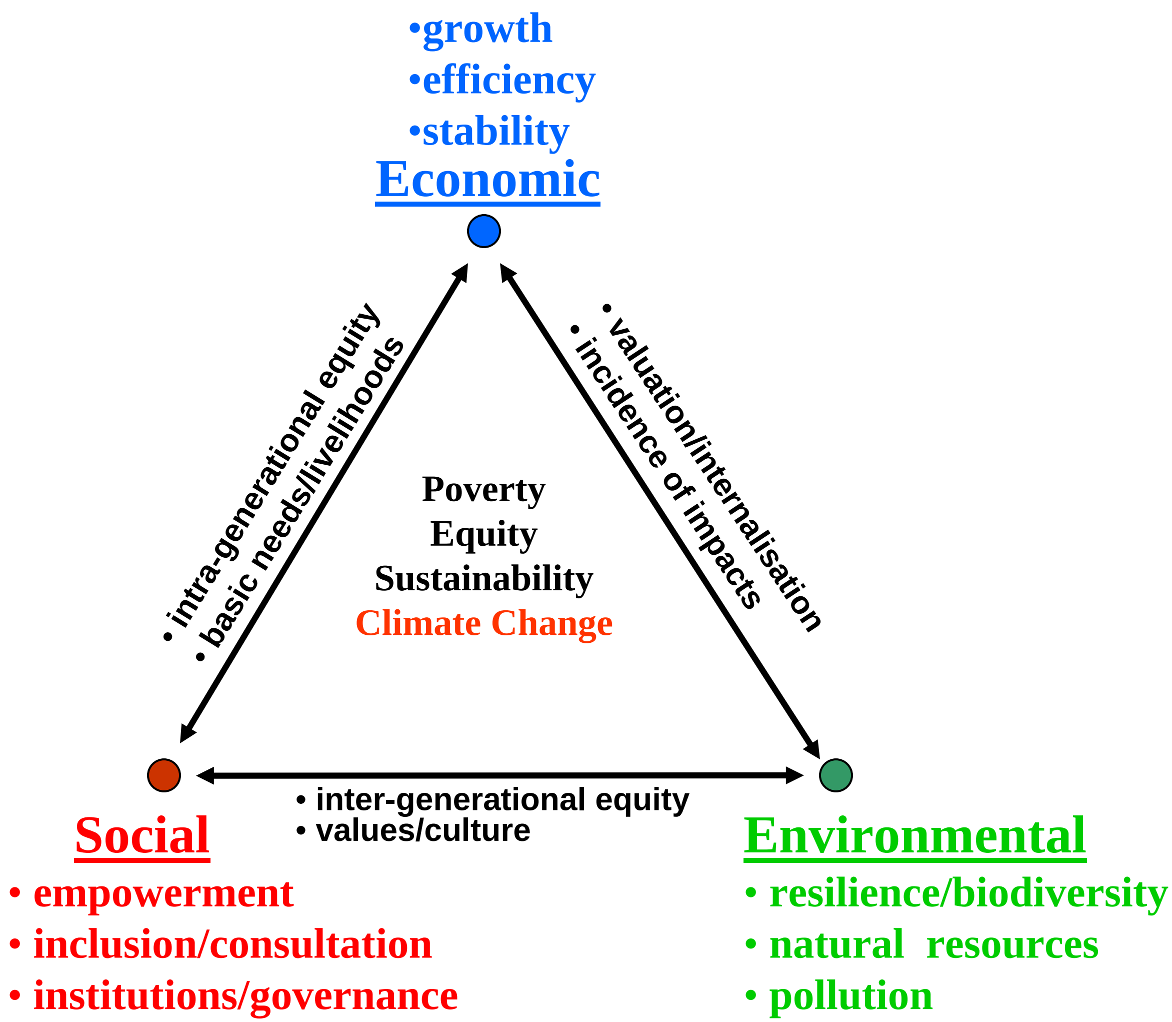
1. Making development more sustainable (MDMS)
2. Sustainable development triangle
3. Transcending boundaries
4. Full cycle application of integrative tools – from data gathering to practical policy implementation



Sustainable Development Triangle - key elements and interconnections (corners, sides and centre)

Source: Munasinghe [1992], Rio Earth Summit

MIND **Munasinghe Institute for Development**



Sustainable Development Triangle - key elements and interconnections (corners, sides and centre)

Source: Munasinghe [1992], Rio Earth Summit

Integrating CC Policies into SD Strategy using Sustainomics

Core concepts and elements

1. Making development more sustainable (MDMS)
2. Sustainable development triangle
3. Transcending boundaries
4. Full cycle application of integrative tools – from data gathering to practical policy implementation

Data can help Transcend Boundaries to Make Development More Sustainable

- Disciplinary
- Space
- Time
- Stakeholder
- Operational

Transcending disciplines to address SD issues

SD Issues

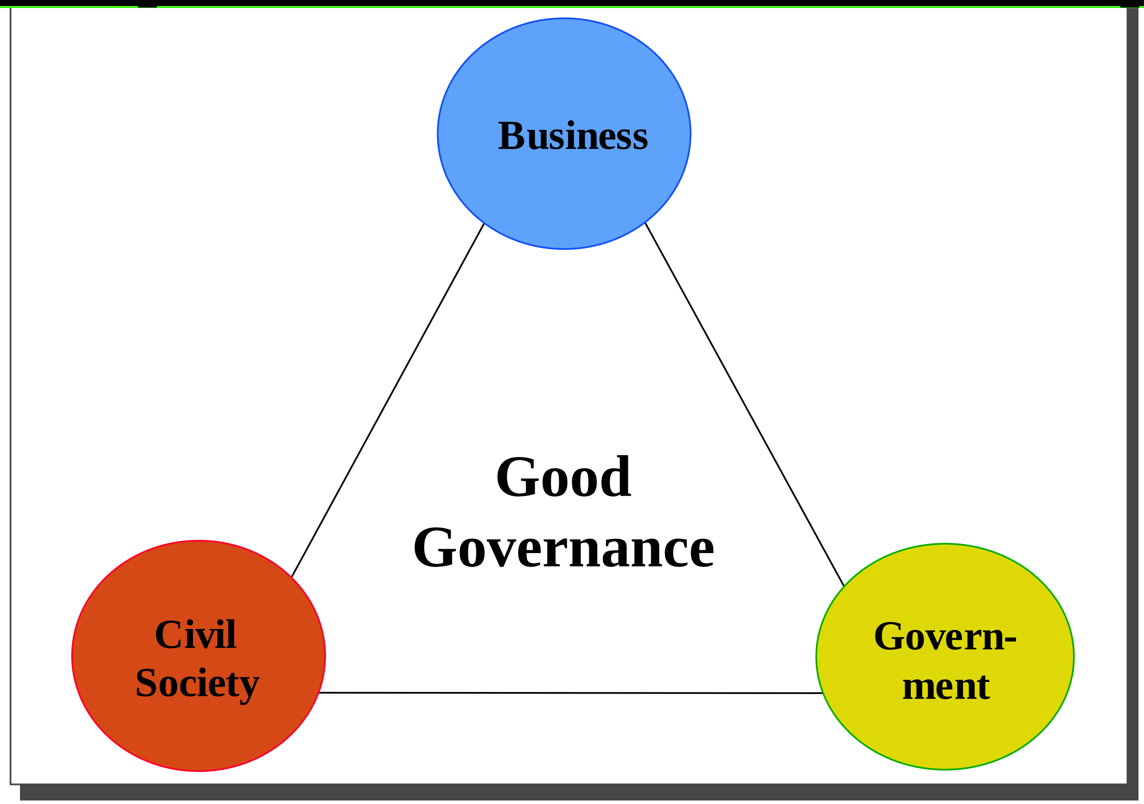
- social justice, equity, values and culture
- institutions and governance
- markets and prices
- technologies and management
- biological and physical resource base

Disciplines

Philosophy
Sociology
Anthropology
Law
Politics
Economics
Finance
Management
Engineering
Ecology
Natural Sciences

Source: **Munasinghe (2002), Int. J. of Sust. Dev.**

Data can help Transcend Stakeholder Boundaries to Ensure Cooperation for Sustainable Development

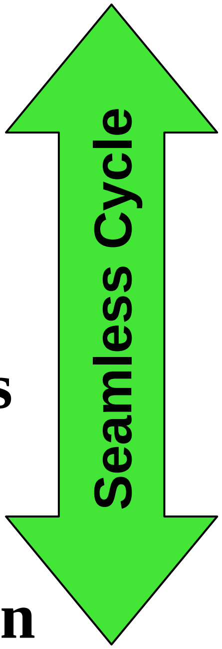


Not only government, but also civil society and business have a vital and balanced role to play in strengthening local, national and global citizenship

Source: Munasinghe (1992), Rio Earth Summit

Data to help Transcend Operational Boundaries

ACTION	**ACTOR**
Observations and Data	Observers
Concepts and Ideas	Thinkers & Philosophers
Models & Analyses	Scientists & Analysts
Interpretation of Results	Translators & Communicators
Plans & Policies	Decision Makers
Practical Implementation	Implementing Agents



Each stage of activity has a tendency to become compartmentalised

Source: Munasinghe (2002), Int. J. of Sust. Dev.

Integrating CC Policies into SD Strategy using Sustainomics

Core concepts and elements

1. Making development more sustainable (MDMS)
2. Sustainable development triangle
3. Transcending boundaries
4. Full cycle application of integrative tools – from data gathering to practical policy implementation

Integrative analytical tools and practical applications
(Data can link across global, national and local levels)

Integrative Analytical Tools

1. Restructuring Growth to Make Development More Sustainable (MDMS)
2. Optimisation and Durability
3. SD Analysis (Macro Level)
4. Action Impact Matrix (AIM)
5. Green Accounting (SEEA-SNA)
6. Integrated Models (IAM, CGE, etc.)
7. SD Analysis (Micro Level)
8. Multi-Criteria Analysis (MCA), Cost-Benefit Analysis (CBA) and Economic Valuation
9. SD Indicators

Application Levels

A. Global-transnational

B. National-macroeconomic

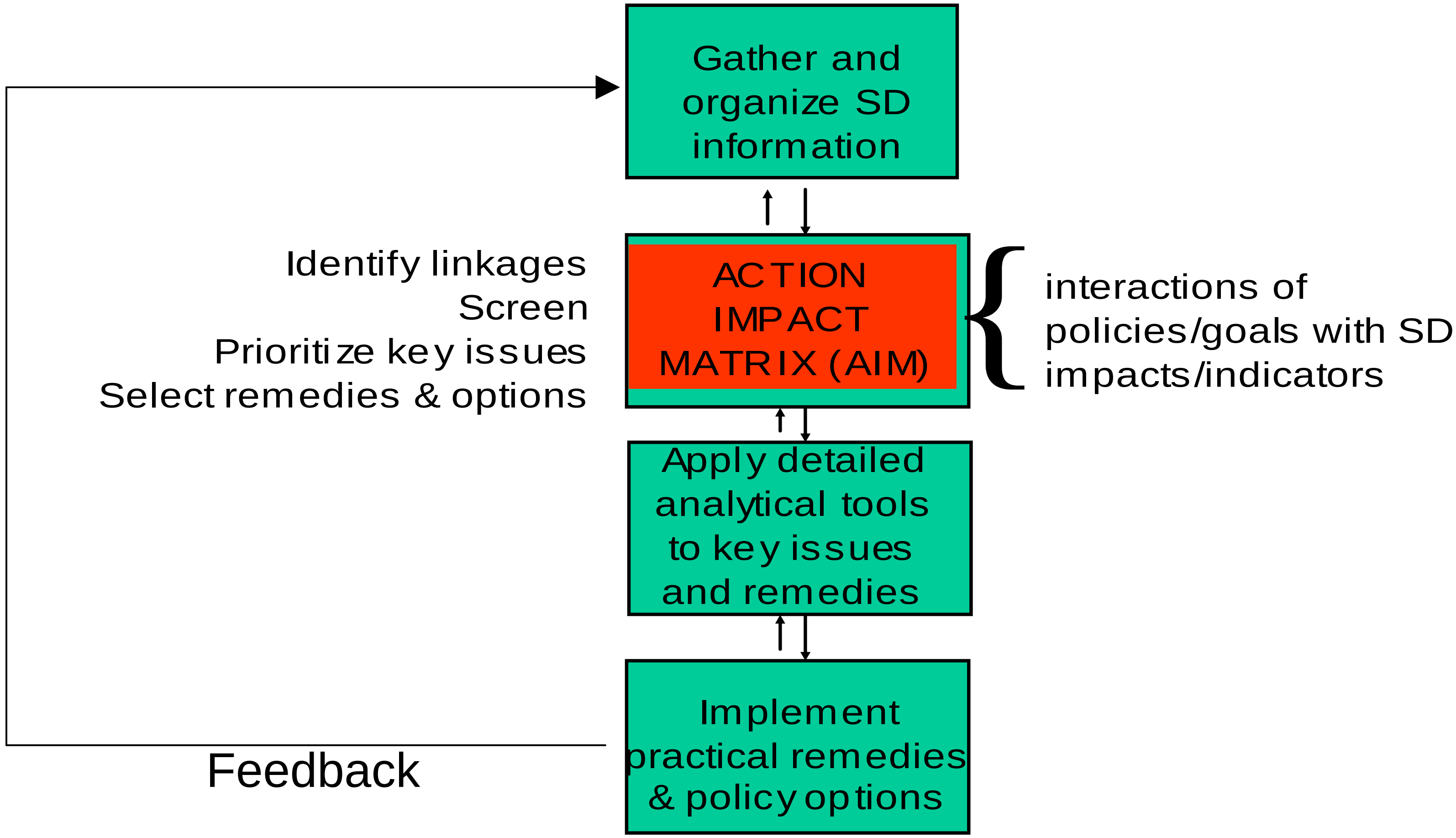
C. Subnational-sectoral

D. Local-project

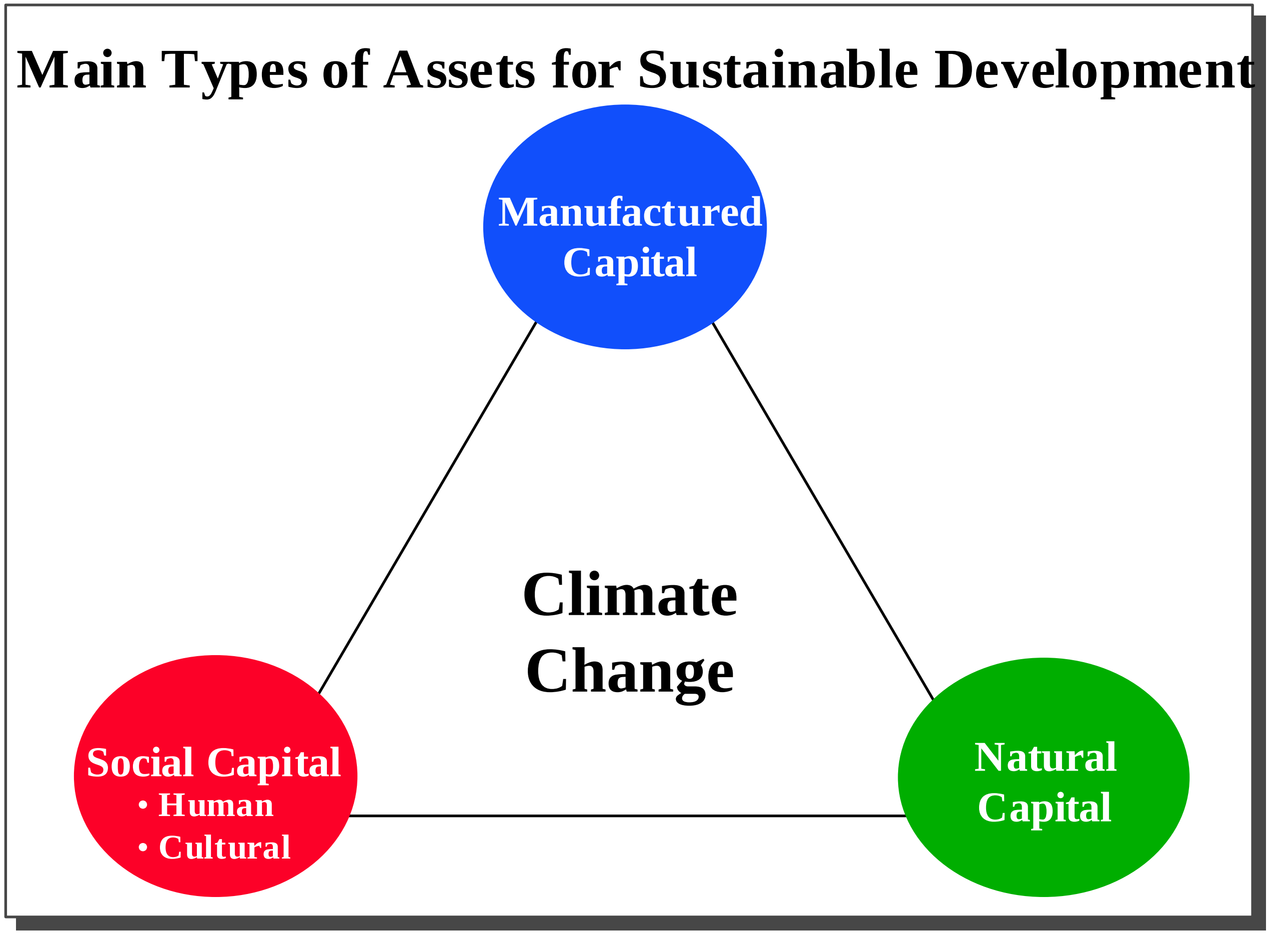
Linkages Across Levels

Integrative tools: Action Impact Matrix (AIM)

Key link from data gathering to practical policy application – requires multidisciplinary data



Solution: Integrating across three dimensions of SD



Economic approach focuses on optimality - maximise growth
Environmental and social approaches rely on durability - system health

Problem: Diverse Definitions of Sustainability

Economic approach focuses on optimality - maximise growth
Environmental and social approaches rely on durability - system health

---

Economic: **Maximum flow of income that could be sustained indefinitely, without reducing stocks of productive assets. Economic efficiency ensures both efficient resource allocation in production and efficient consumption that maximises utility.**

Ecological: **Preserving the viability and normal functioning of natural systems, including system health ability to adapt to shocks across a range of spatial and temporal scales. Defined by a comprehensive, multiscale, hierarchical, dynamic measure describing system resilience, vigour and organization.**

Social: **Maintaining the resilience of social systems and limiting their vulnerability to sudden shocks. Involves building social capital to strengthen cohesion, protecting cultural diversity and values, and improving inclusion and participation - especially of disadvantaged groups.**

SD Indicators

- Social
- Environmental
- Economic
- Institutional

many indicators are available; thus choice is critical for specific task at hand

WHY ? is climate a threat to future human development
Climate Change (CC) undermines Sustainable Development (SD) and unfairly penalizes the poor

HOW ? can we better understand CC-SD links and identify specific issues
Analyze how CC affects SD and vice versa using the Sustainomics framework

WHAT? are the practical solutions and policy options to be implemented that will integrate CC responses into SD strategy (from global to local levels)
Many examples of good practice available.
Improved statistics will play a key role.

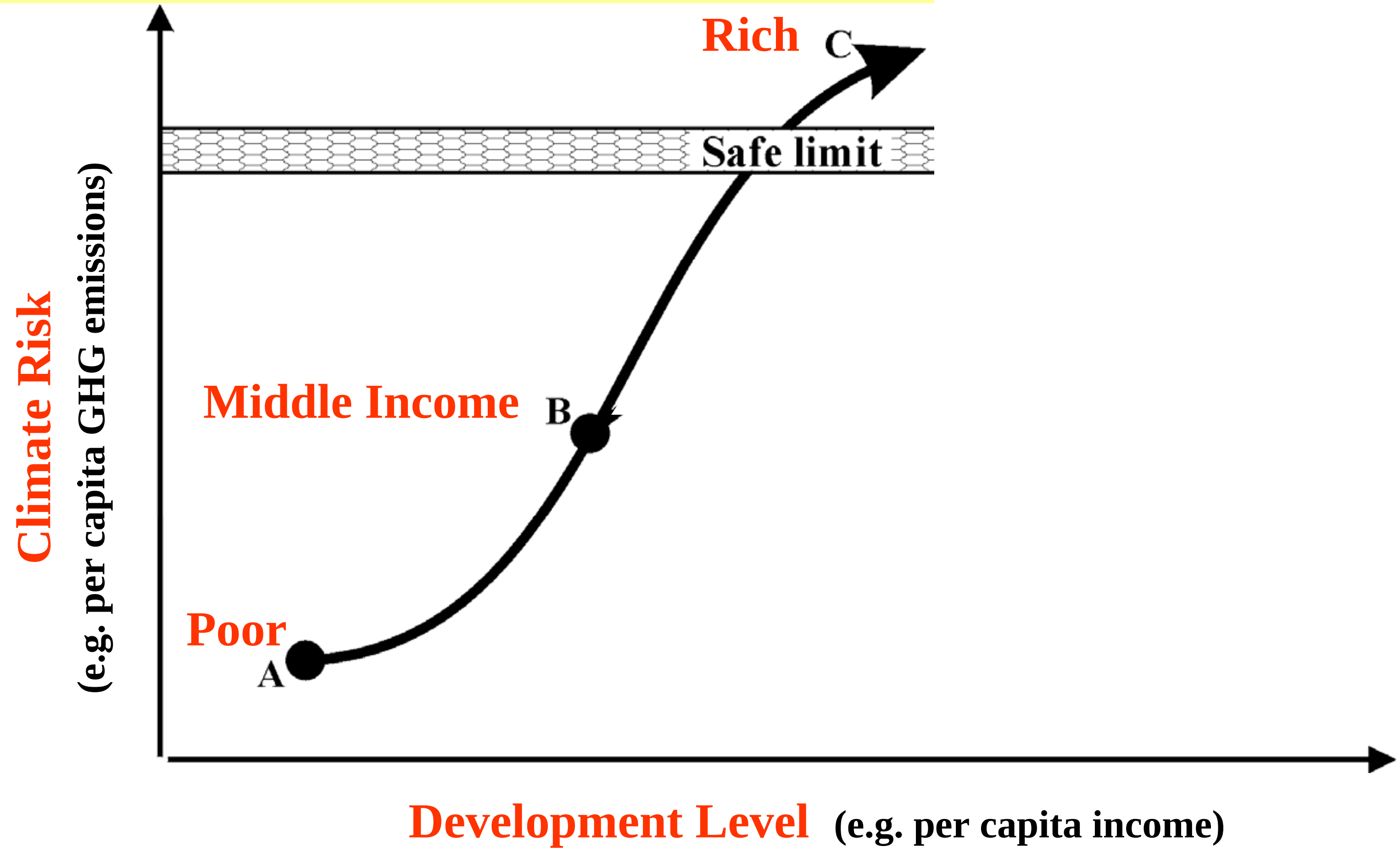
Practical Application of Sustainomics to Complex CC-SD Interactions

Global, National and Project Level Examples

Making Development More Sustainable: “Tunneling” Framework for Reconciling Mitigation Burden and Right to Develop

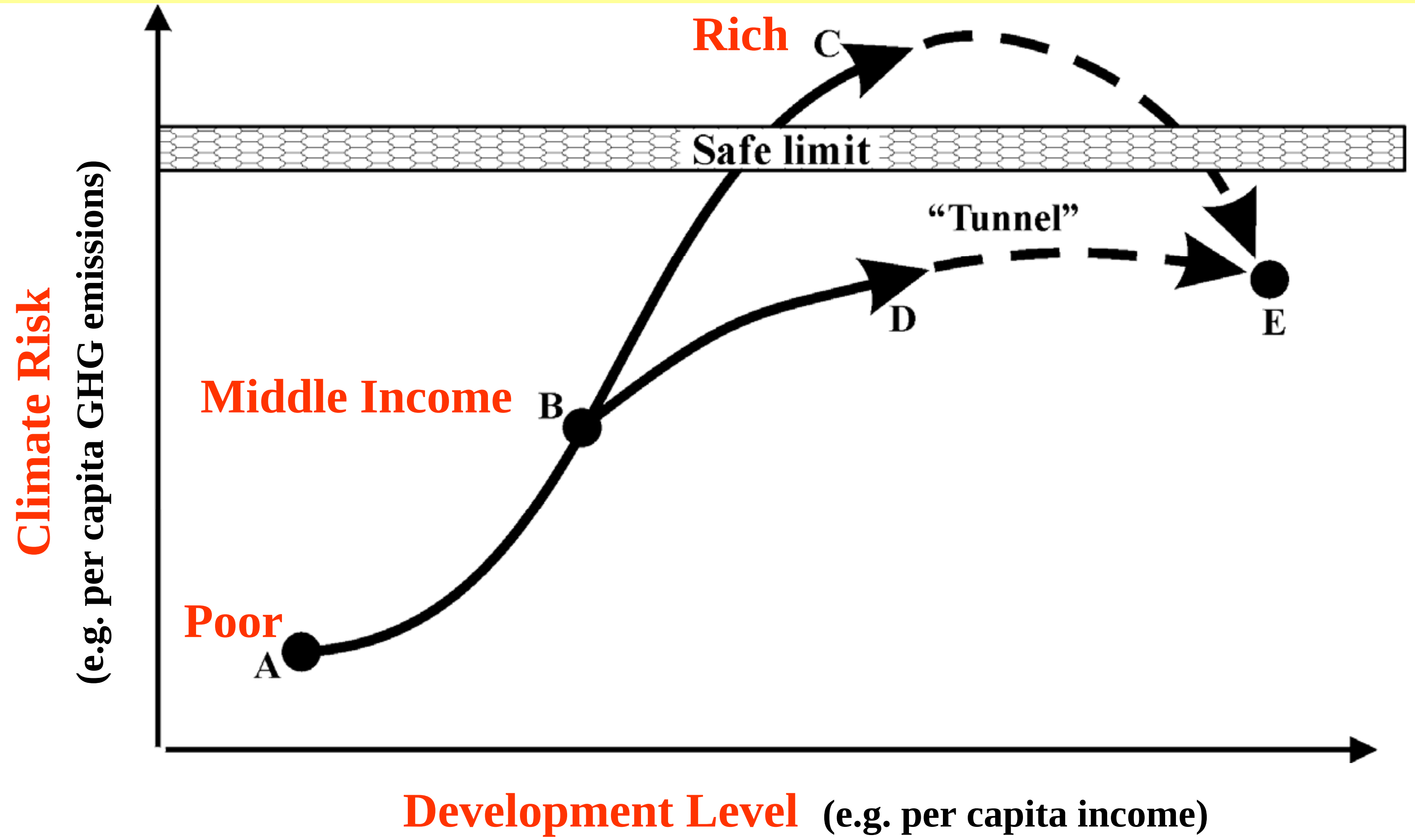
Climate Change Responses and Sustainable Development need not be conflicting objectives

MDMS via "Tunneling" : Framework for Reaching Consensus on Climate Risk vs. Development Rights



Source**: M. Munasinghe (1995) "Making Growth More Sustainable," *Ecological Economics*, 15:121-4**.

MDMS via "Tunneling" : Framework for Reaching Consensus on Climate Risk vs. Development Rights

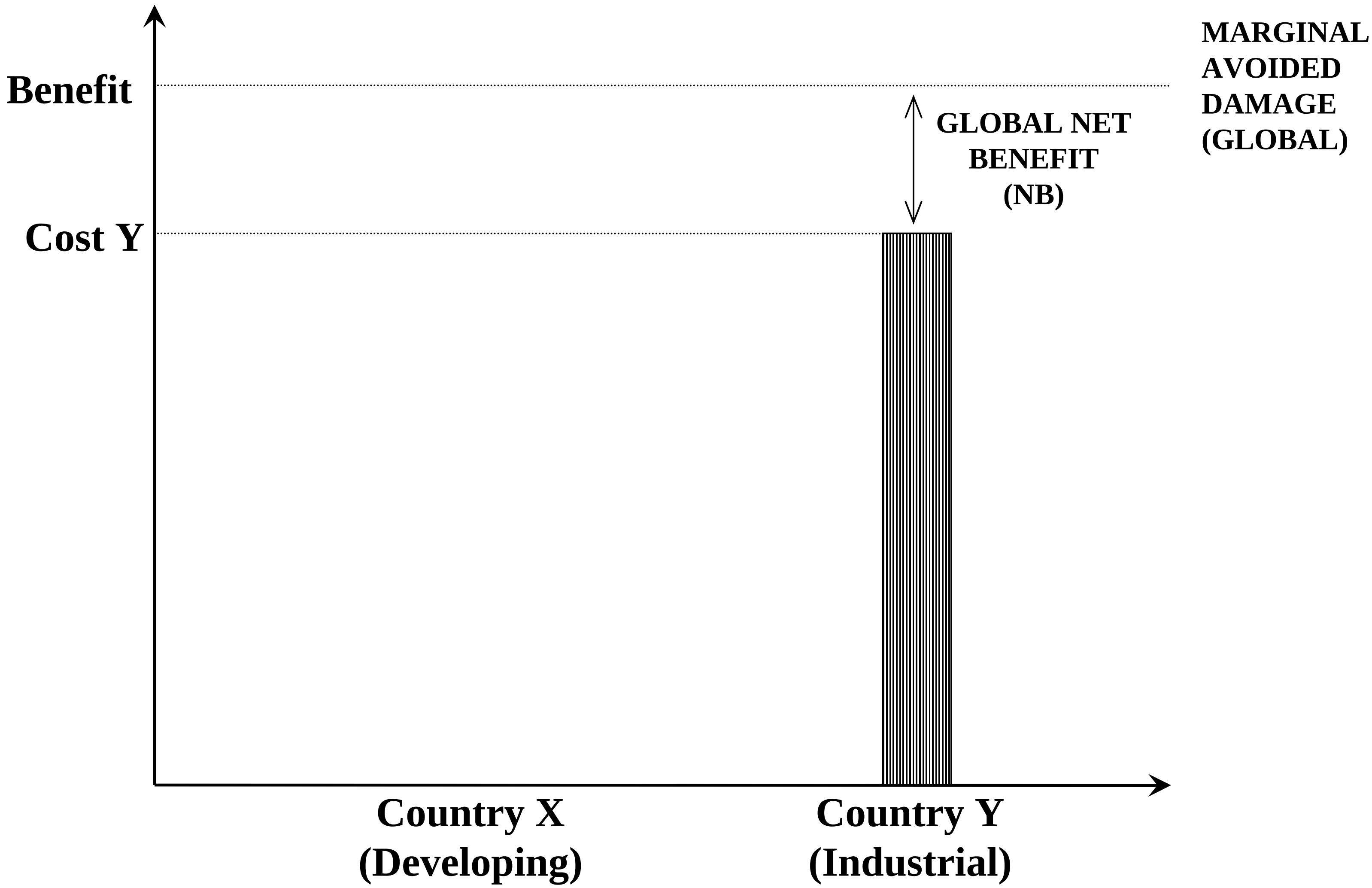


Source: **M. Munasinghe (1995) "Making Growth More Sustainable,"** ***Ecological Economics***, **15:121-4**.

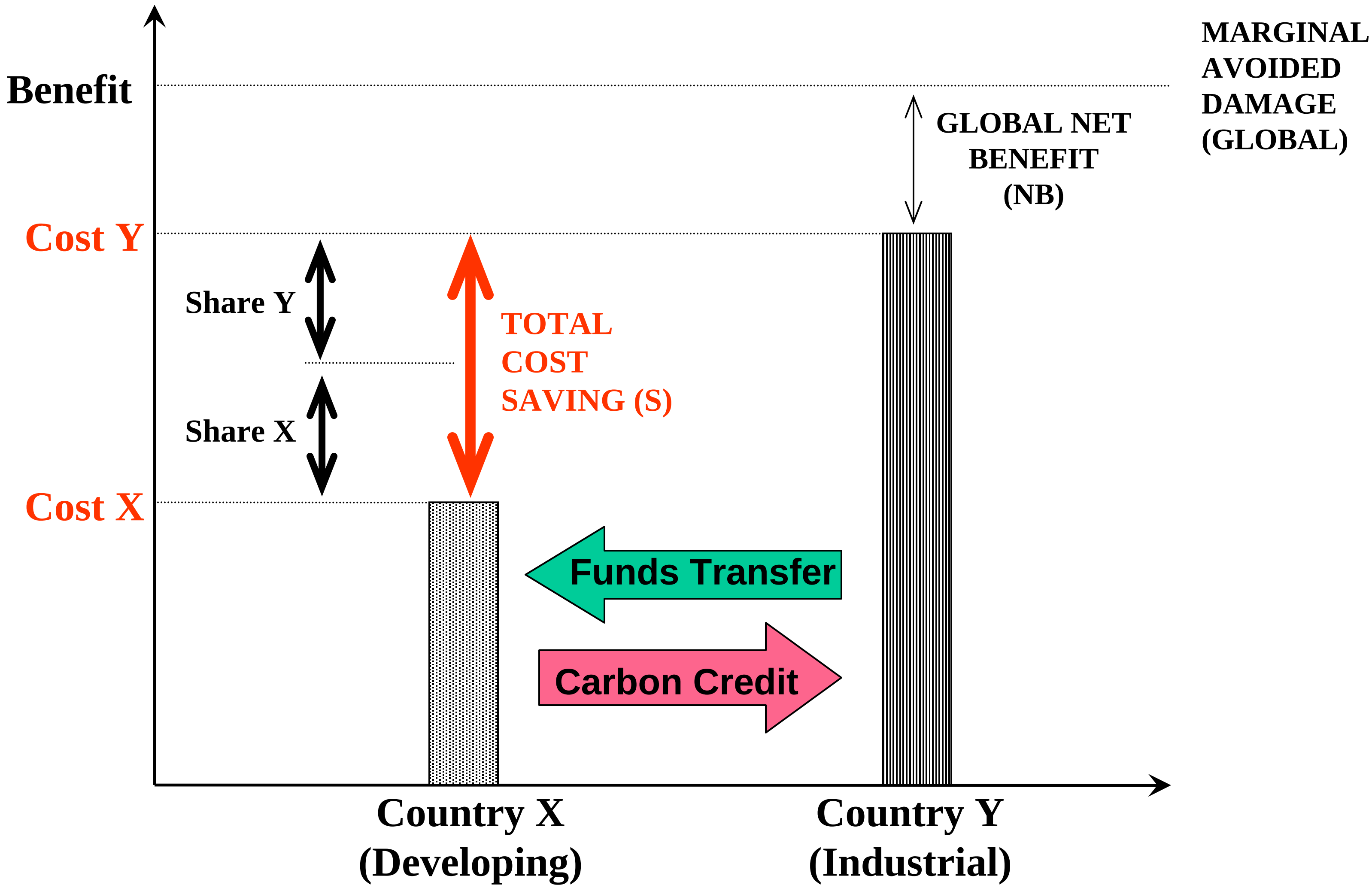
Specific Mitigation Mechanisms

Interplay of Economic Efficiency and Social Equity to Protect the Global Environment - Flexibility Mechanisms: Clean Development Mechanism (CDM), JI & Emissions Trading

Interplay of Economic Efficiency and Social Equity to Protect Global Environment - CDM & JI: 1



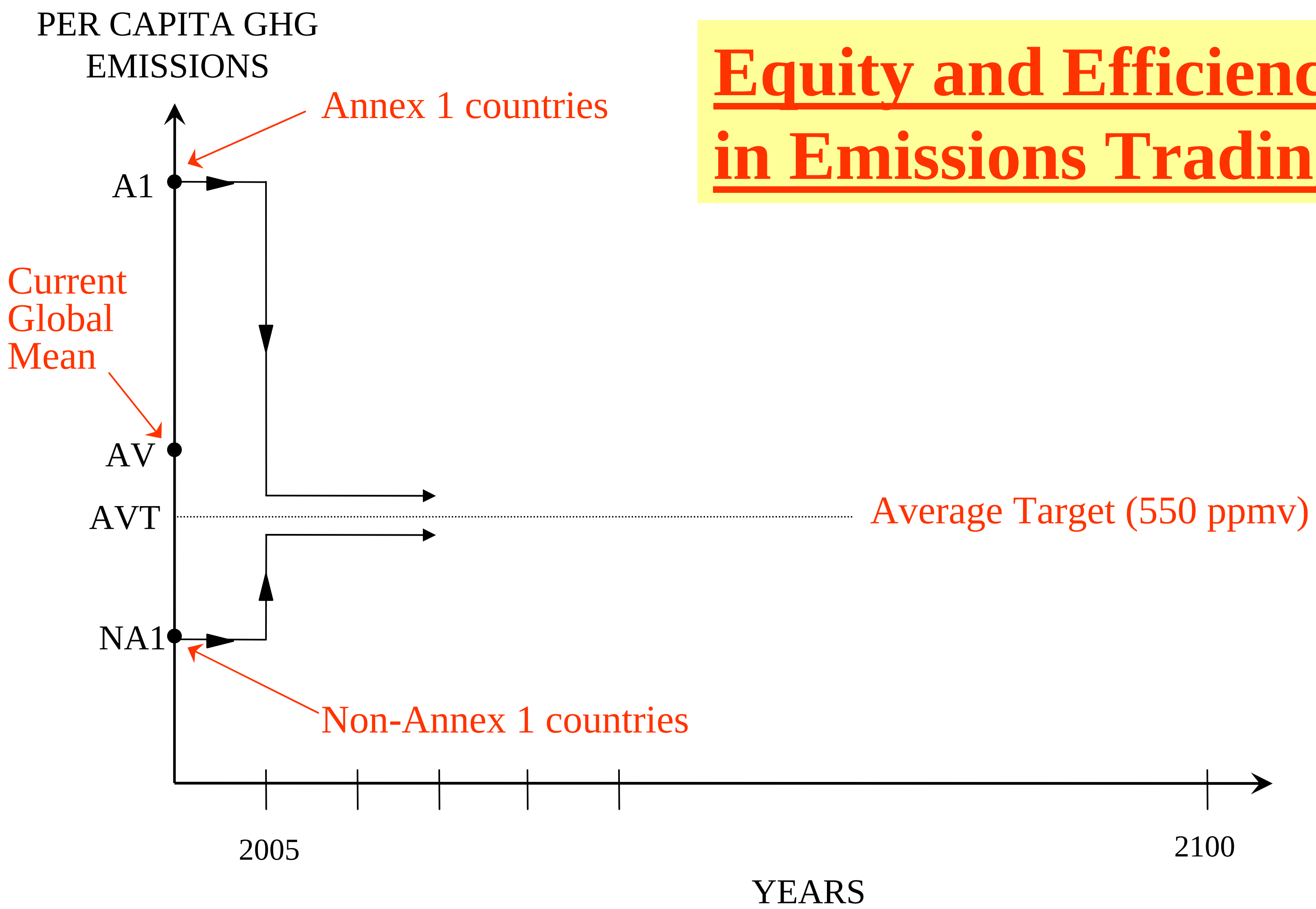
Interplay of Economic Efficiency and Social Equity to Protect Global Environment - CDM & JI: 2



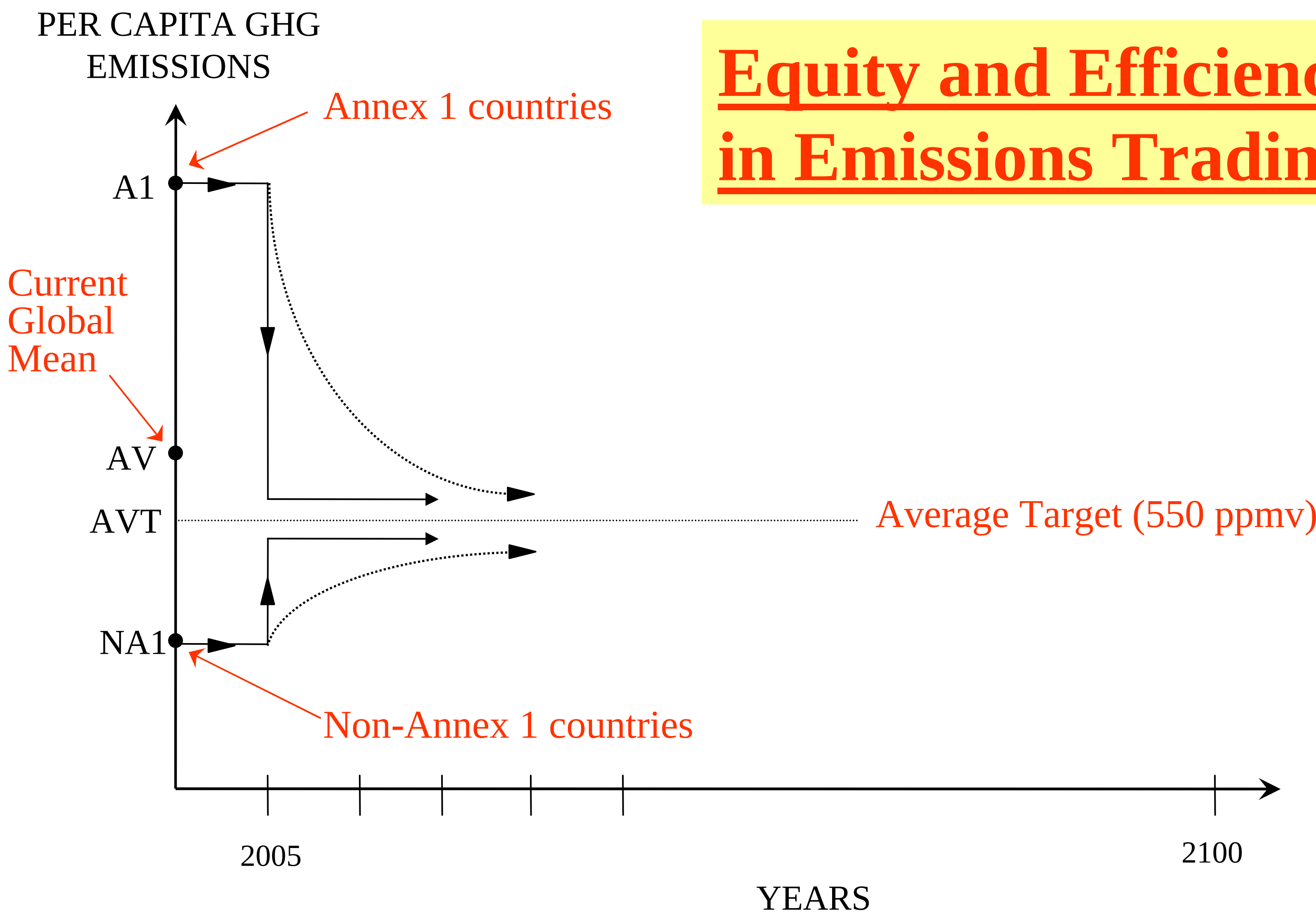
MIND

Munasinghe Institute for Development

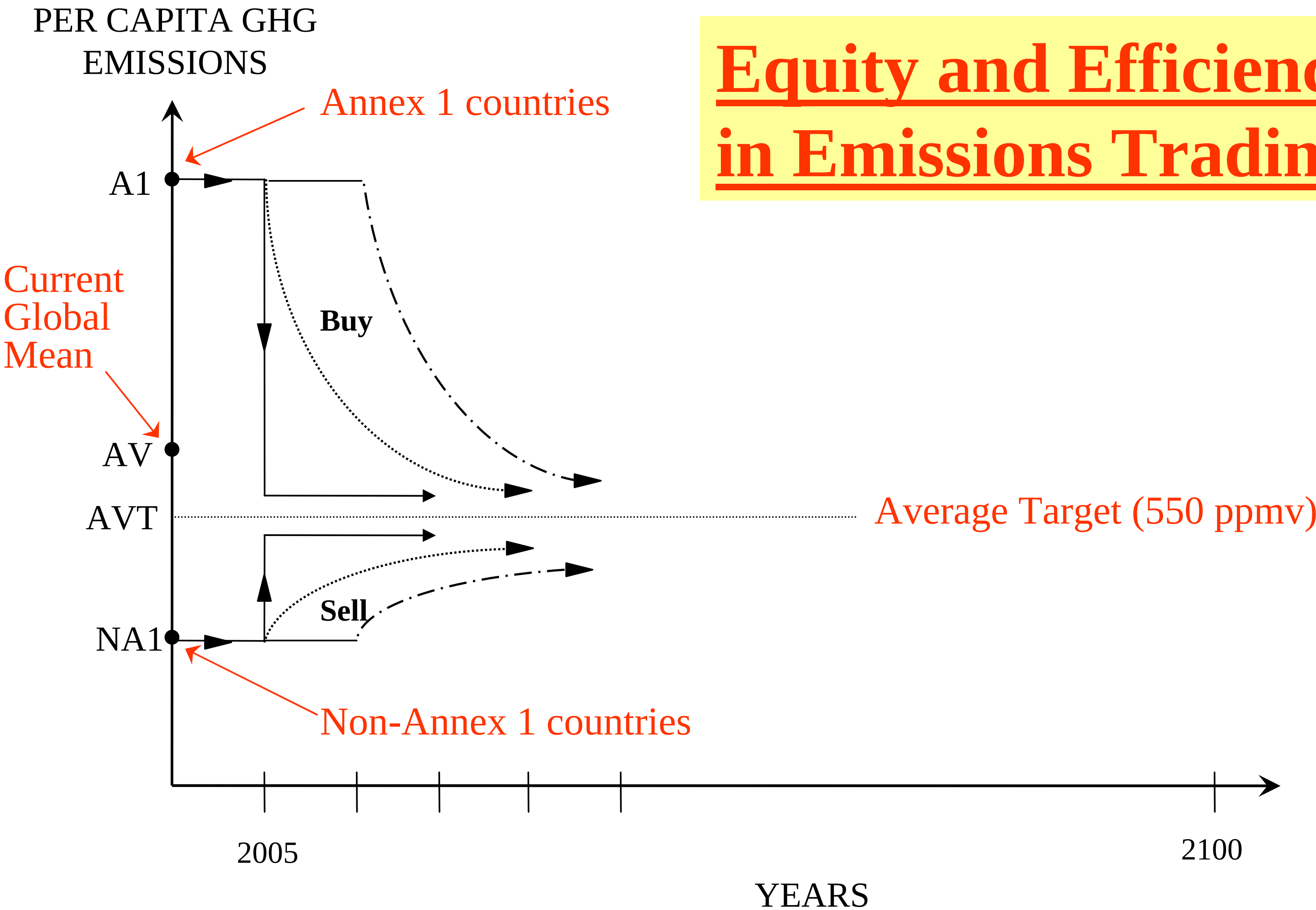
Equity and Efficiency in Emissions Trading 1



Equity and Efficiency in Emissions Trading 2



Equity and Efficiency in Emissions Trading 3



Country Level Actions

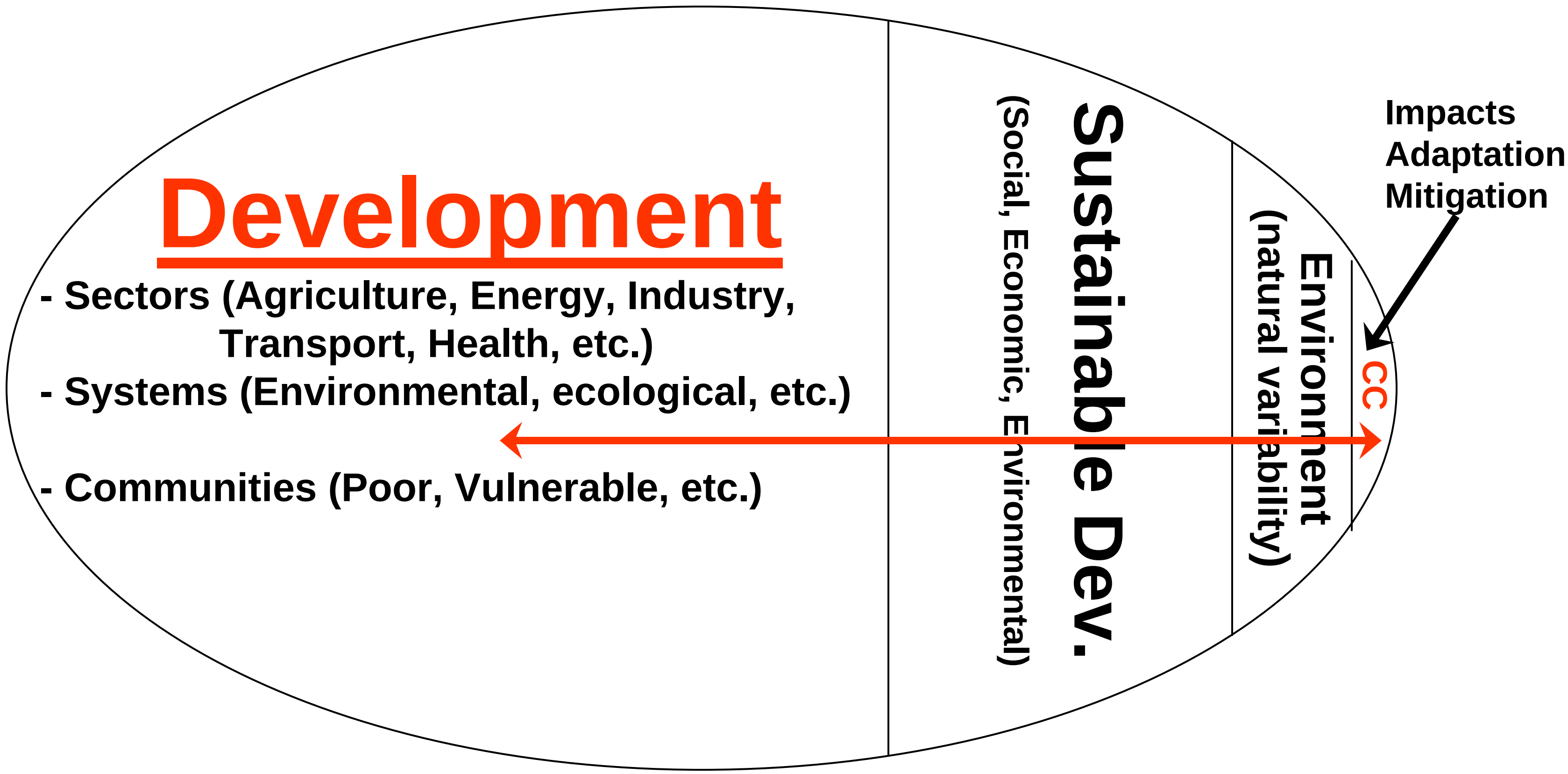
Integrating Climate Change Policies into National Sustainable Development Strategy

Typical Response Options for a National Climate Change Strategy

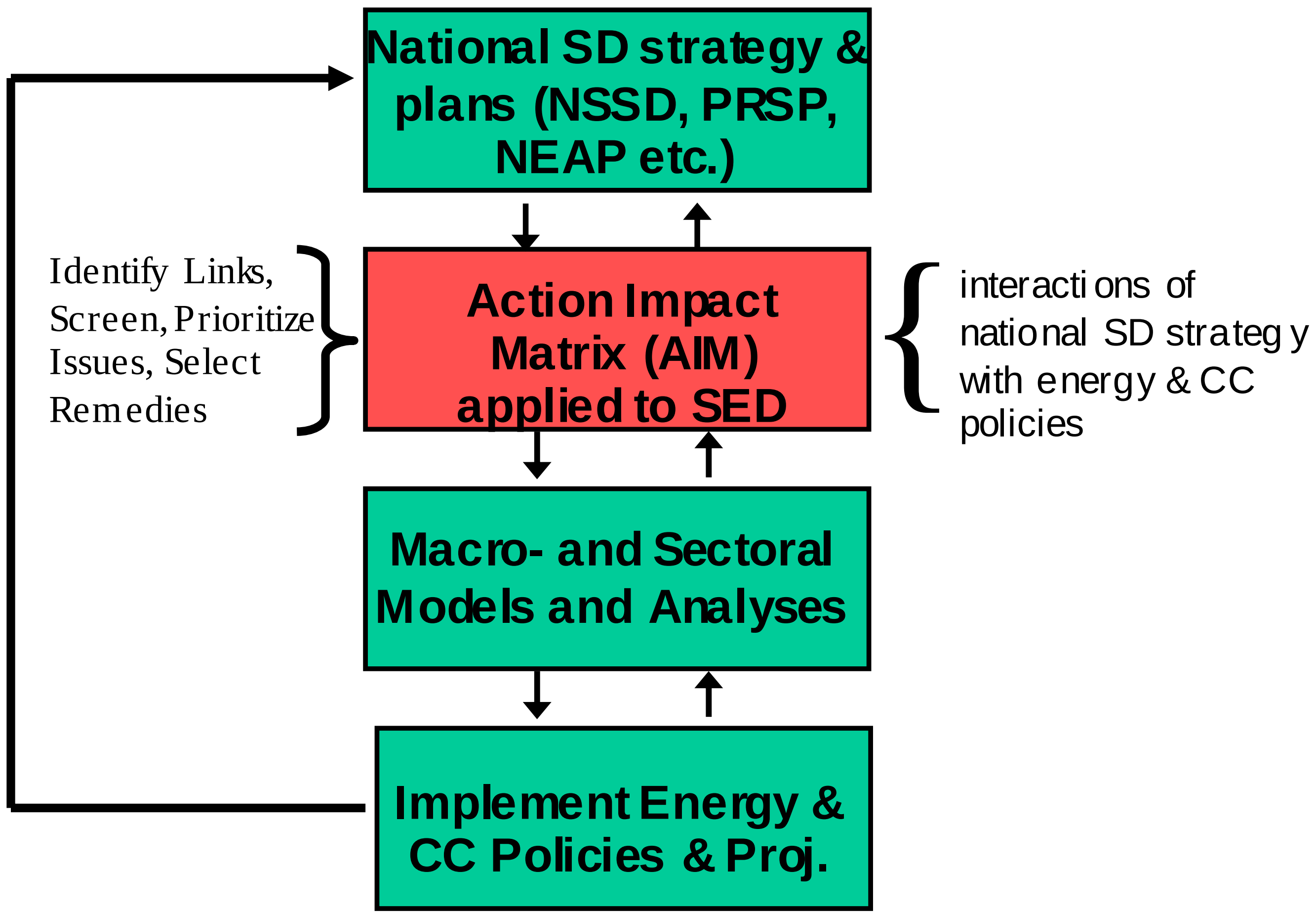
1. **Grow Fast (reduce vulnerability to CC)**
2. **Improve adaptive capacity (reduce impacts)**
3. **Mitigate (FX incentives needed to offset costs)**
4. **Integrate CC-SD strategy by combining 1,2 & 3**

National Level CC-SD Links

Decision makers see climate change as a minor element in the national sustainable development strategy



Analysing SD-CC Interactions using the Action Impact Matrix (AIM) to Link Macro & Micro Levels



Action Impact Matrix (AIM) Methodology

The AIM methodology may be used to better understand interactions among key elements, at the country-specific level:

(a) national development policies and goals;

(b) climate change adaptation (or mitigation) options.

First, the impacts of (a) on (b) are explored, in the context of both natural climate variability and additional effects of climate change. Then the reverse impacts of (b) on (a) are studied.

The AIM approach analyses key economic-environmental-social interactions to identify potential barriers to making development more sustainable (MDMS) - including climate change. It also helps to determine the priority macro strategies and micro policies in the economic, social and environmental domains, that facilitate implementation of adaptation and mitigation measures to address the impacts of climate change.

Thus, the AIM helps to integrate CC within SD. It has been used since the early 1990s to link macroeconomic policies and environment.

AIM Process

The AIM methodology relies on a fully participative stakeholder exercise to generate the AIM itself. Up to 50 experts are drawn from government, academia, civil society and the private sector, who represent various disciplines and sectors relevant to both sustainable development and climate change. In the initial exercise, they usually interact intensively over a period of about two days, to build a preliminary AIM. This participative process is as important as the product (i.e., the AIM), since important synergies and cooperative team-building activities emerge. The collaboration helps participants to better understand opposing viewpoints, resolves conflicts, and ultimately facilitates implementation of agreed policy remedies. On subsequent occasions, the updating or fine-tuning of the initial AIM can be done within a few hours by the same group, since they are already conversant with the methodology.

Building the AIM – Step 1: Identify Rows and Columns

Row Headings: key national macro-economic goals and policies.
Column Headings: key vulnerable areas (VA), and associated economic, environmental and social indicators.

		Vulnerable Areas (VA)			
		Economic		Environmental	Social
		(1) Agricultural output	(2) Industrial Activity	(3) Water Resources	(4) Health
Dev. Goals/Policies					
(A)	Growth				
(B)	Poverty alleviation				
(C)	Food Security				
(D)	Employment				

Adaptation Effects on Development (VED-AIM) in Sri Lanka – CC Impacts and Effects of VA on Development Goals/Policies

Notation
+ Beneficial
- Harmful
3 High
2 Moderate
1 Low

Key Vulnerabilities, Impacts and Adaptation (VIA)

		(1) Agric. Output	(2) Hydro Power	(3) Deforestation	(4) Bio-div. (flora & fauna)	(5) Wet-lands & coastl ecosystems	(6) Water resources	(7) Poor communities	(8) Human health	(9) Infra-struct.	(10) Industries & Tour-ism
(S0)	Status (Nat. Variability)	-1	0	-2	-1	-1	-2	-1	0	2	2
(S1)	Status (+CC Impacts =>)	-2	-1	-2	-2	-2	-3	-2	-1	-1	-1
Dev. Goals/Policies (+CC Impacts)											
(A)	Growth	-1	-1	-1	-1	-1	-2	-2	-1	-1	-1
(B)	Poverty alleviation	-2	0	-1	-1	-1	-2	-2	-2	-1	-1
(C)	Food Security	-3	0	-1	-1	-1	-3	-1	-1	0	0
(D)	Employment	-1	0	-1	0	-1	-2	-1	-2	-1	-2
(E)	Trade & Globalisation	-2	-1	0	0	0	-1	-1	0	-2	-1
(F)	Budget Deficit Reduction	-1	-1	0	0	0	0	0	-2	0	-1
(G)	Privatisation	0	1	1	0	0	1	0	0	-1	-1

Integration via SD Analysis at the Macroeconomic/Sectoral Level (general equilibrium analysis)

1. Macroeconomic/Sectoral Modeling
2. Environmental and Macroeconomic Analysis
3. Poverty/Income Distributional Analysis

Expanded Green National Income Accounts for SD

Social Accounting Matrix (SAM)

Economic Links Basic Input-Output Table	**Environmental-Economic Links** Satellite Environmental Accounts (Impacts/Loads)
Economic-Social Links Distribution of Income	**Envir.-Social Links** Distribution of Environmental Impacts/Loads

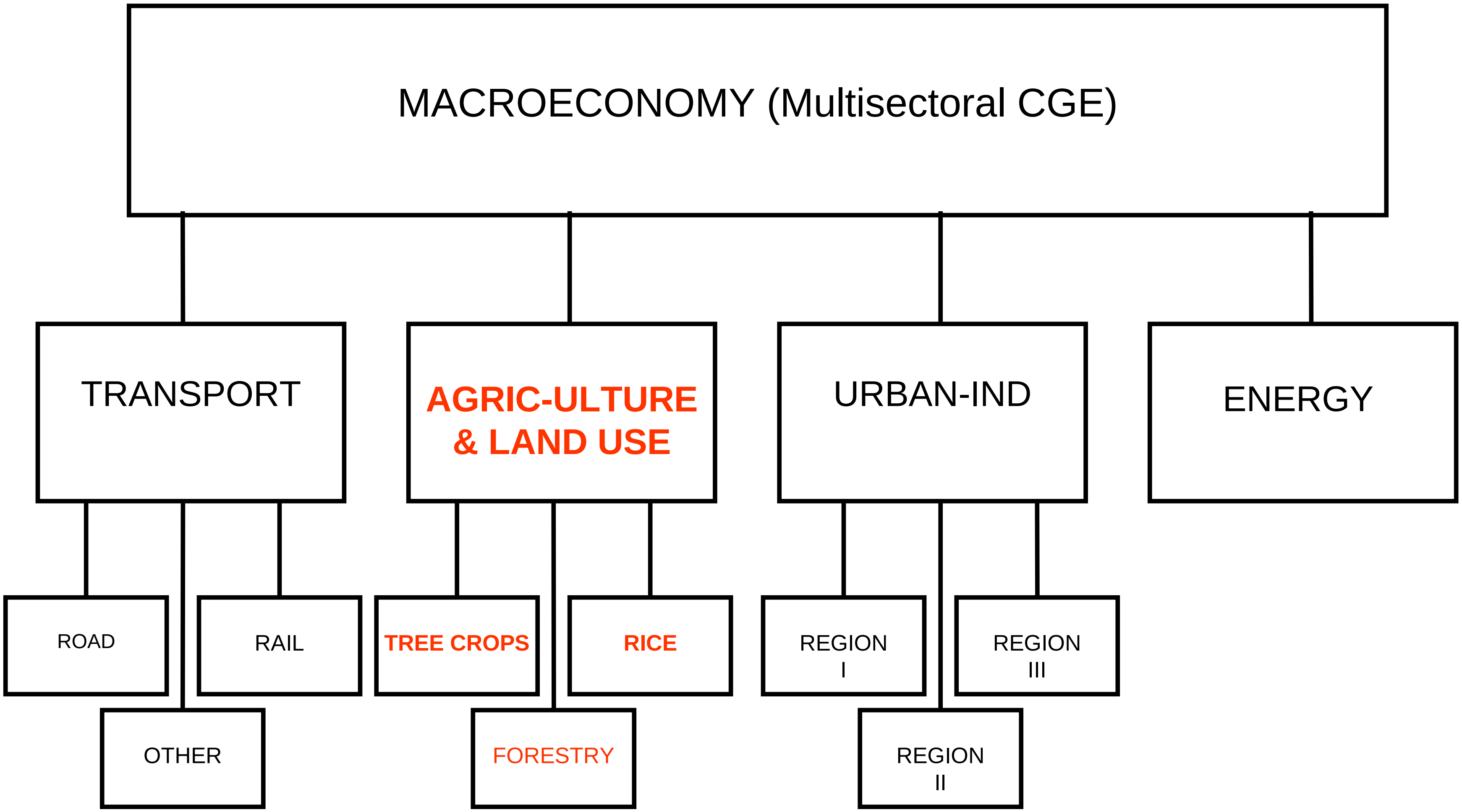
Source: Munasinghe (2001), Macroeconomics and Environment

AIM Detailed Follow-up Study: <u>Sector Example</u>

Analysing Climate Change Impacts on Agriculture in Sri Lanka Using a Ricardian Model

Source: M. Munasinghe and S. Perera (1996)

Sri Lanka Integrated CC-SD Assessment Model



Climate Model Predictions for Sri Lanka in 2050 (Downscaled GCM)

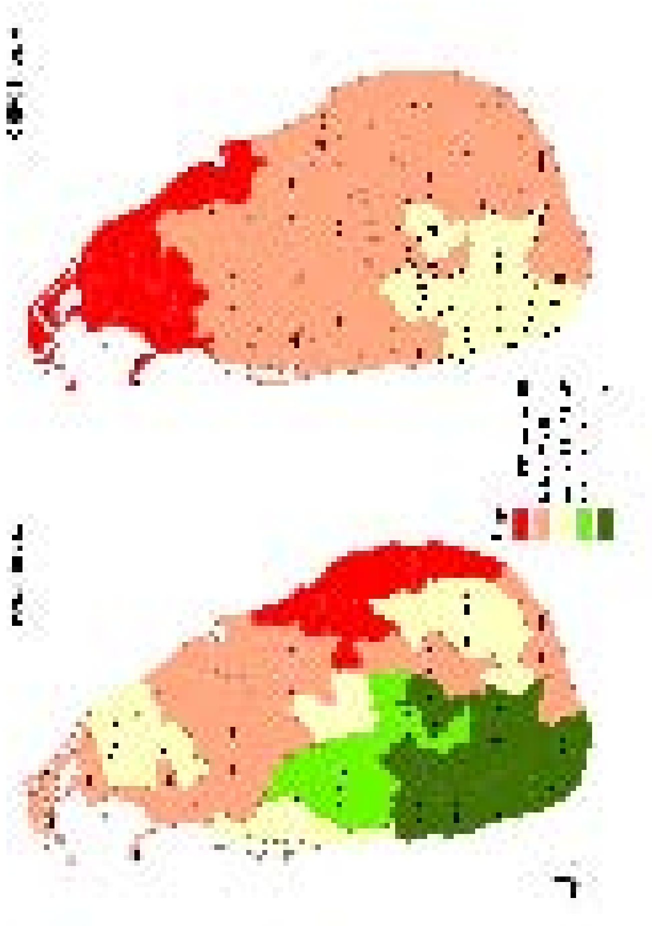
Global Scenario	Period	Rainfall	Temperature
B1	NEM	Increase by 50 mm over the baseline	Max. temperature: increase by 0.8^{0} C Min. temperature : increase by 1.0^{0} C
B1	SWM	Increase by 350 mm over the baseline, especially over the Western slopes of the central hills	Max. temperature: increase by 0.8^{0} C Min. temperature : increase by 0.8^{0} C
A1F1	NEM	Increase by 70 mm over the baseline, especially over the Eastern slopes of the central hills	Max. temperature: increase by 1.1^{0} C Min. temperature : increase by 1.4^{0} C
A1F1	SWM	Increase by 520 mm over the baseline, especially over the Western slopes of the central hills	Max. temperature: increase by 1.1^{0} C Min. temperature : increase by 1.2^{0} C

Impact on Sri Lanka national economy in 2050* - GDP effect small BUT equity effect larger

Crop	Change of Total GDP in 2050 (%)	Change Agriculture GDP in 2050 (%)
Rice (dry zone – poorer)	-0.36	-2.46
Plantation Crops (wet zone – richer)	+0.10	+0.70
Rice + Plantation Crops	-0.26	- 1.76

***Note: Assuming the same economic structure in 2050**

Sri Lanka Impacts: HAD3 and CSIRO models



Some Key Policy Implications for Sri Lankan Decision Makers

1. **Overall impact** on agricultural output and national economy is modest, but some effects will emerge within next two decades
2. **Food impact:** potential risk to food security (rice)
3. **Poverty impact** on small farmers
4. **Equity impact:** losers - small rice farms in dry zone, gainers - large export crop plantations in wet zone)
5. **Demographic impact:** potential migration from dry to wet zone

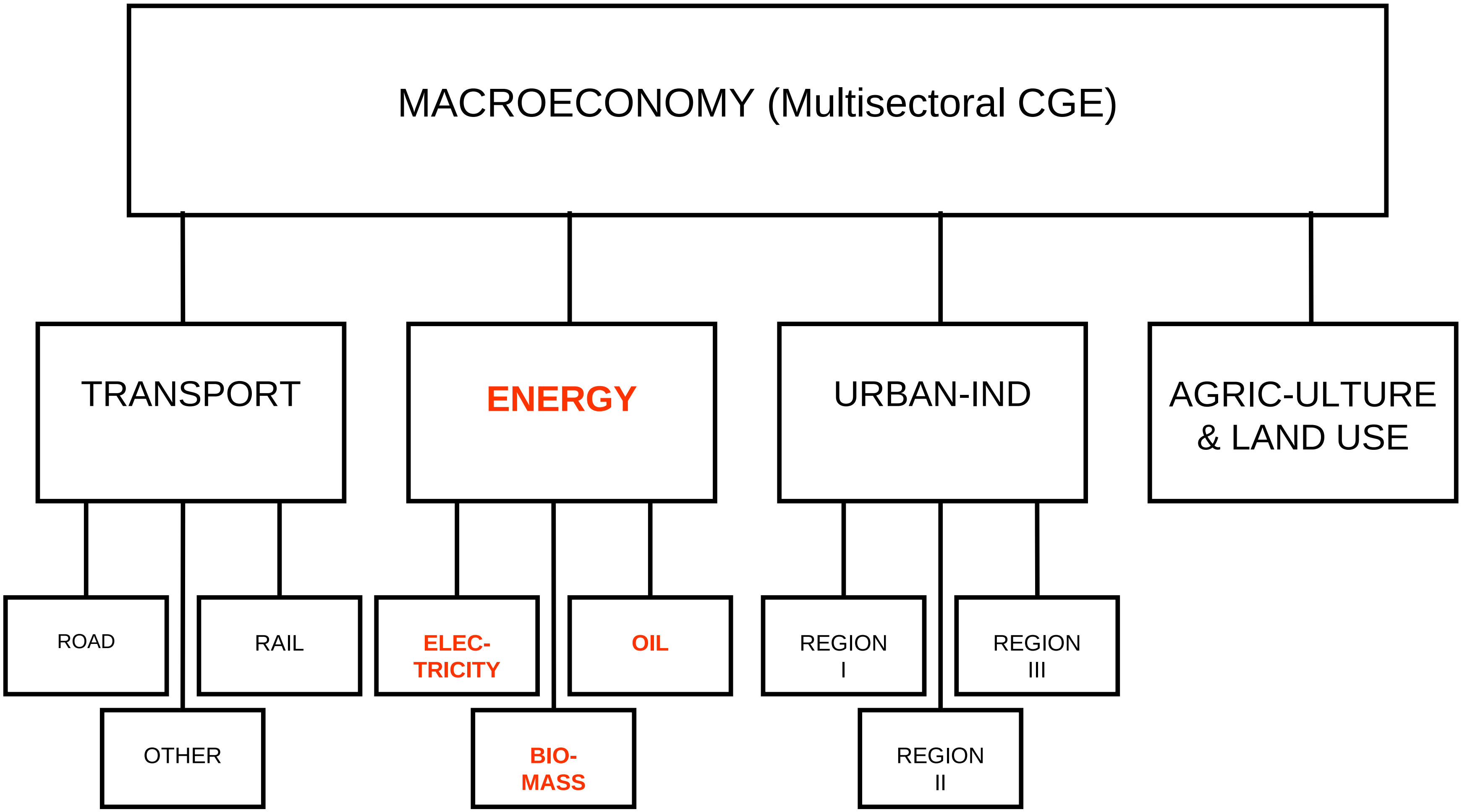
Change in net agriculture income: Results of various Ricardian models

Country	Temperature rise (^{0} C) plus 7% rainfall increase	Change in net income (percent)	Source
Sri Lanka	2.0	-27	Basic model – Analysis 1 (this paper)
Sri Lanka	3.5	-46	Basic model – Analysis 1 (this paper)
Sri Lanka - Paddy	2.0	-10	Improved agricultural data - Analysis 2 (this paper)
Sri Lanka – Plantation crops	2.0	+39	Improved agricultural data - Analysis 2 (this paper)
Sri Lanka - Paddy	Temp.= +1.1 to 1.2 ^{0}C & Rainfall = +70 to 520 mm	- 11.4	Improved agricultural and climate data - Analysis 2 (this paper)
Sri Lanka - Plantation crops	Temp.= +1.1 to 1.2 ^{0} C & Rainfall = +70 to 520 mm	+ 3.5	Improved agricultural and climate data - Analysis 2 (this paper)
United States	2.0	-3 to +3	Mendelsohn, Nordhaus, and Shaw (1994)
India	2.0	-3 to -6	Sanghi, Mendelsohn, and Dinar (1998)
India	3.5	-3 to -8	Sanghi, Mendelsohn, and Dinar (1998)
India	2.0	-7 to -9	Kumar and Parikh (1998a)
India	3.5	-20 to -26	Kumar and Parikh (1998a)
Brazil	2.0	-5 to -11	Sanghi (1998)
Brazil	3.5	-7 to -14	Sanghi (1998)

National Level Example

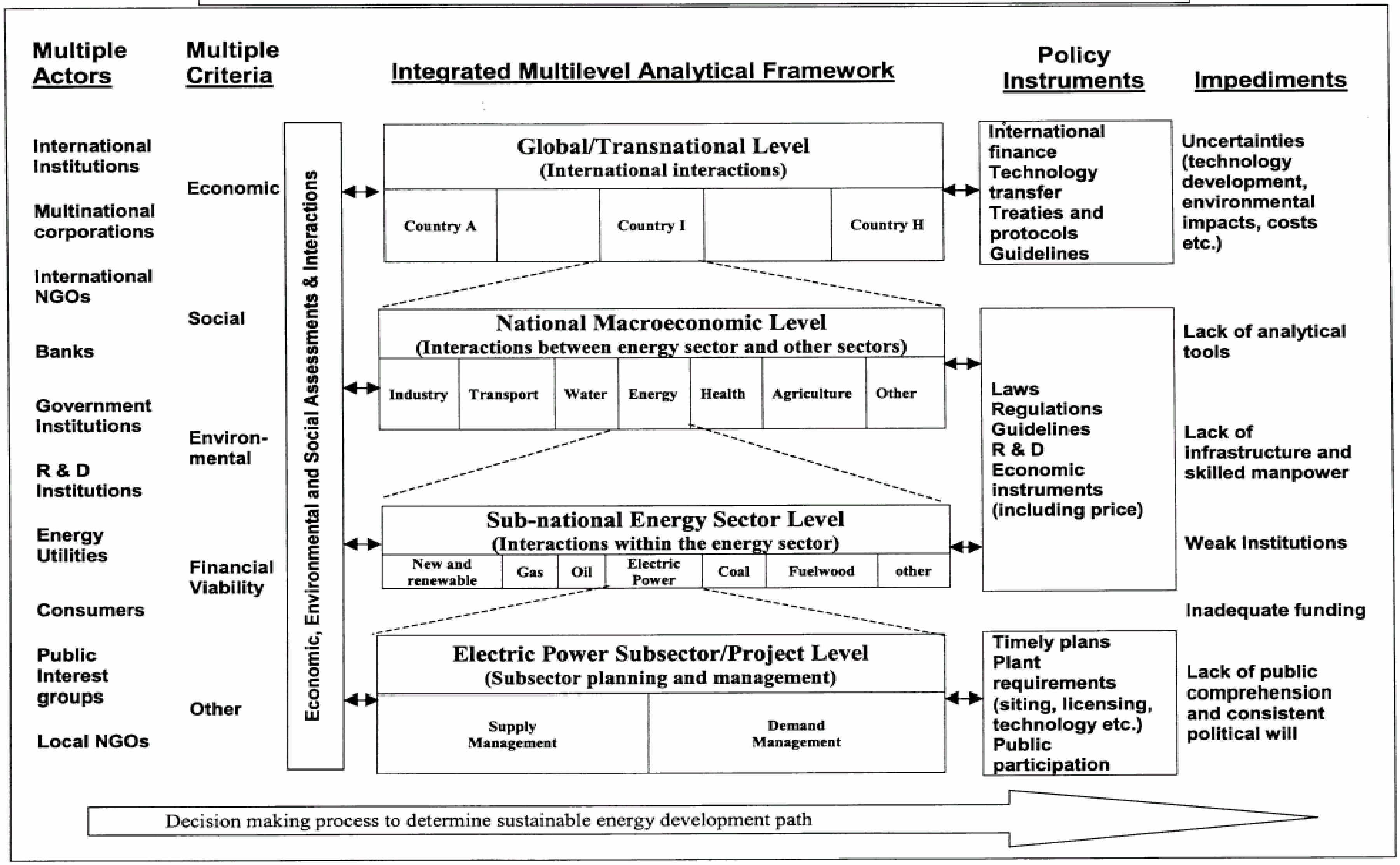
Energy Sector Policy and Pricing

Integrated Sustainable Energy Development Model



Sustainable Energy Development and Mitigation

Figure 8. Framework for sustainable energy development Source: adapted from Munasinghe [1990].



Sustainable Energy Pricing: incorporates Economic, Environmental and Social Goals
(requires variety of corresponding data)

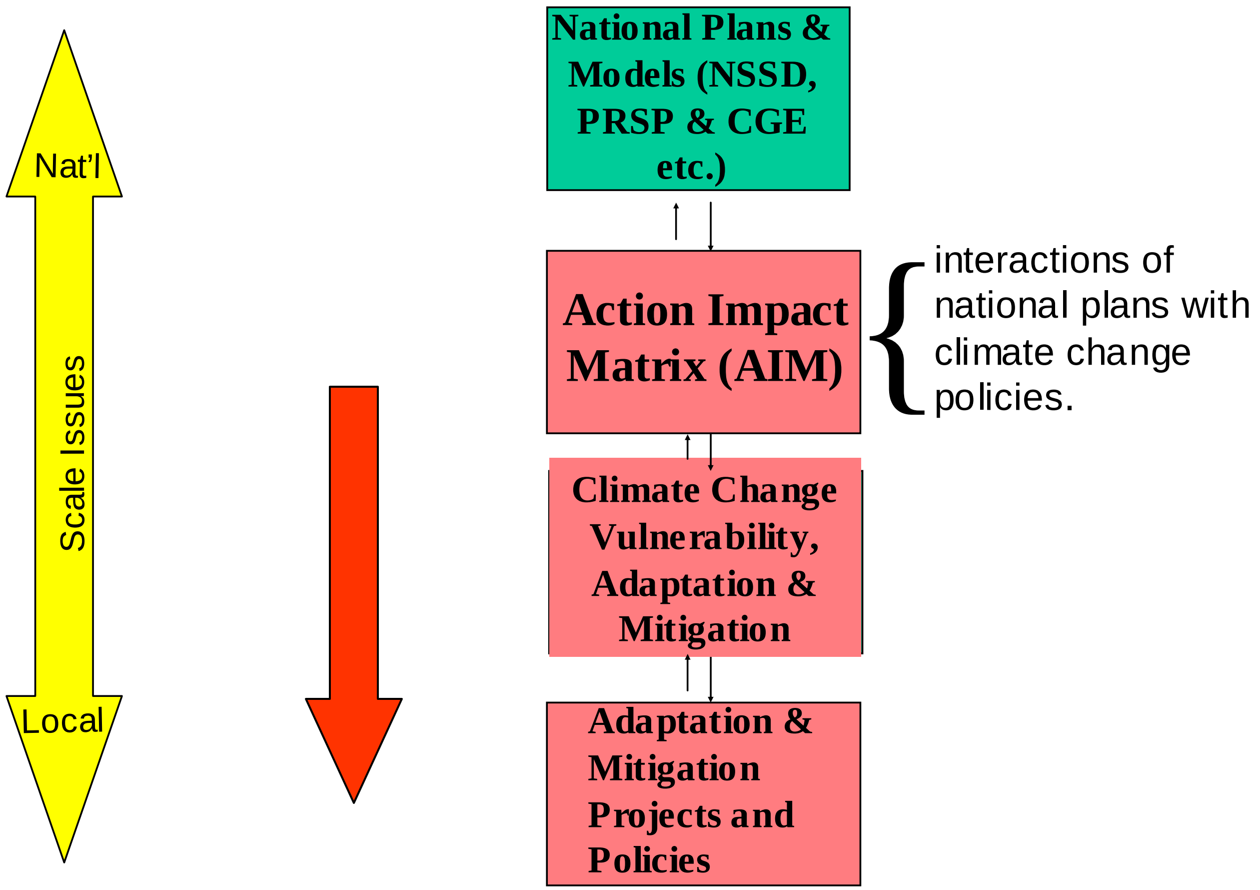
1. **Economic efficiency: prices based on long-run marginal cost to reflect scarcity**
   e.g., rising oil prices

2. **Environmental protection: prices incorporate (internalise) externalities**
   e.g., add air pollution taxes, carbon taxes, etc.

3. **Social equity: subsidised prices to meet basic energy needs of the poor**
   e.g., reduced or lifeline prices for minimum use by poor

Subnational-Sectoral and Local-Project Level Examples

Assessing links between development plans and adaptation and mitigation: AIM-Micro/Project Linkage Downwards



Sustainable Development Assessment (SDA)
(partial equilibrium analysis at sector/project level)

1. Economic/Financial Assessment (CBA)

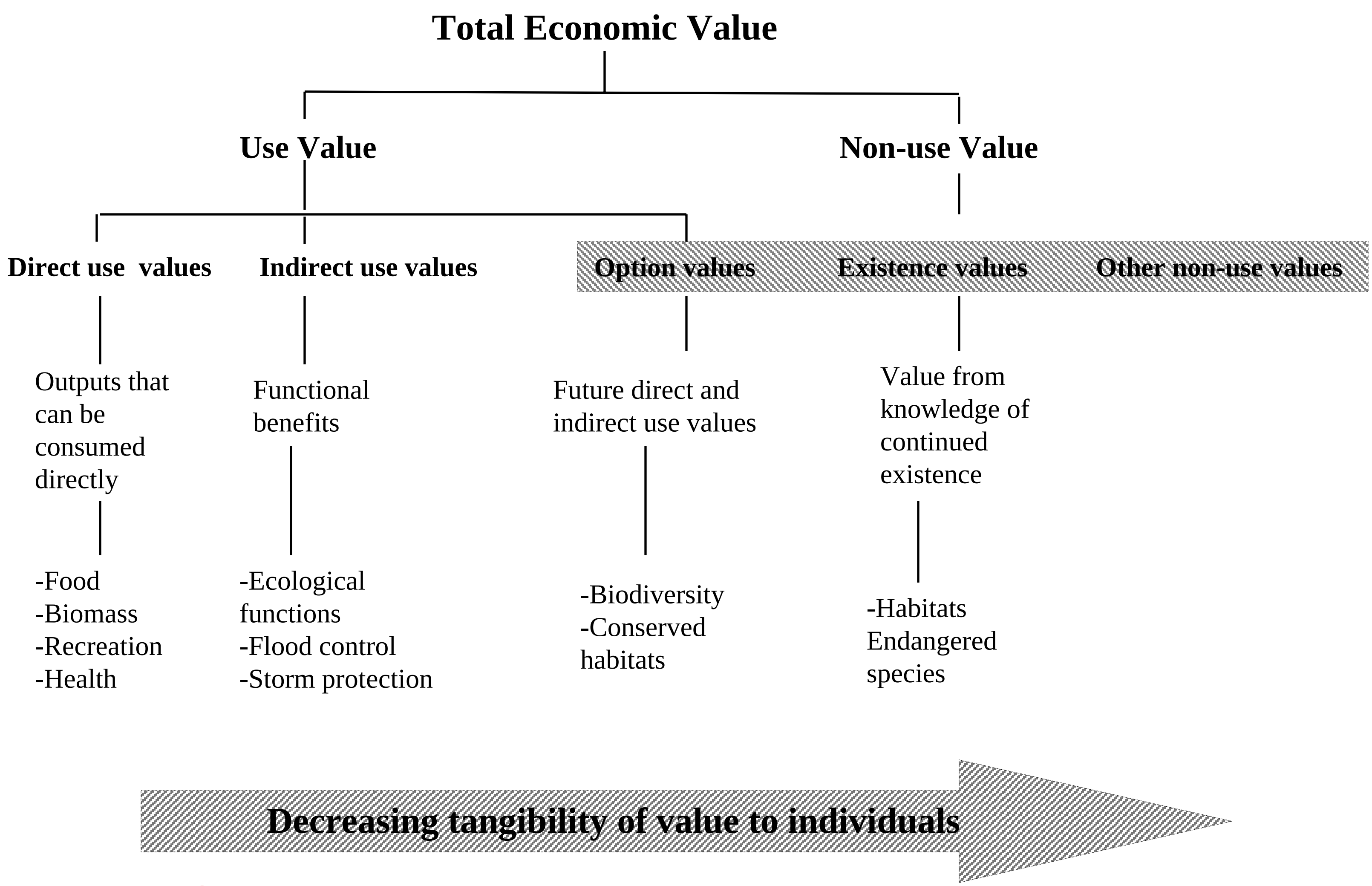
2. Environmental Assessment (EA)

3. Social Assessment (SA)

4. Poverty Assessment (PA)

5. Technical Assessment (TA)

Choice of appropriate SD indicators is vital for SD Assessment



Categories of economic values attributed to environmental assets (examples from a tropical rain forest).

Techniques for economically valuing environmental impacts

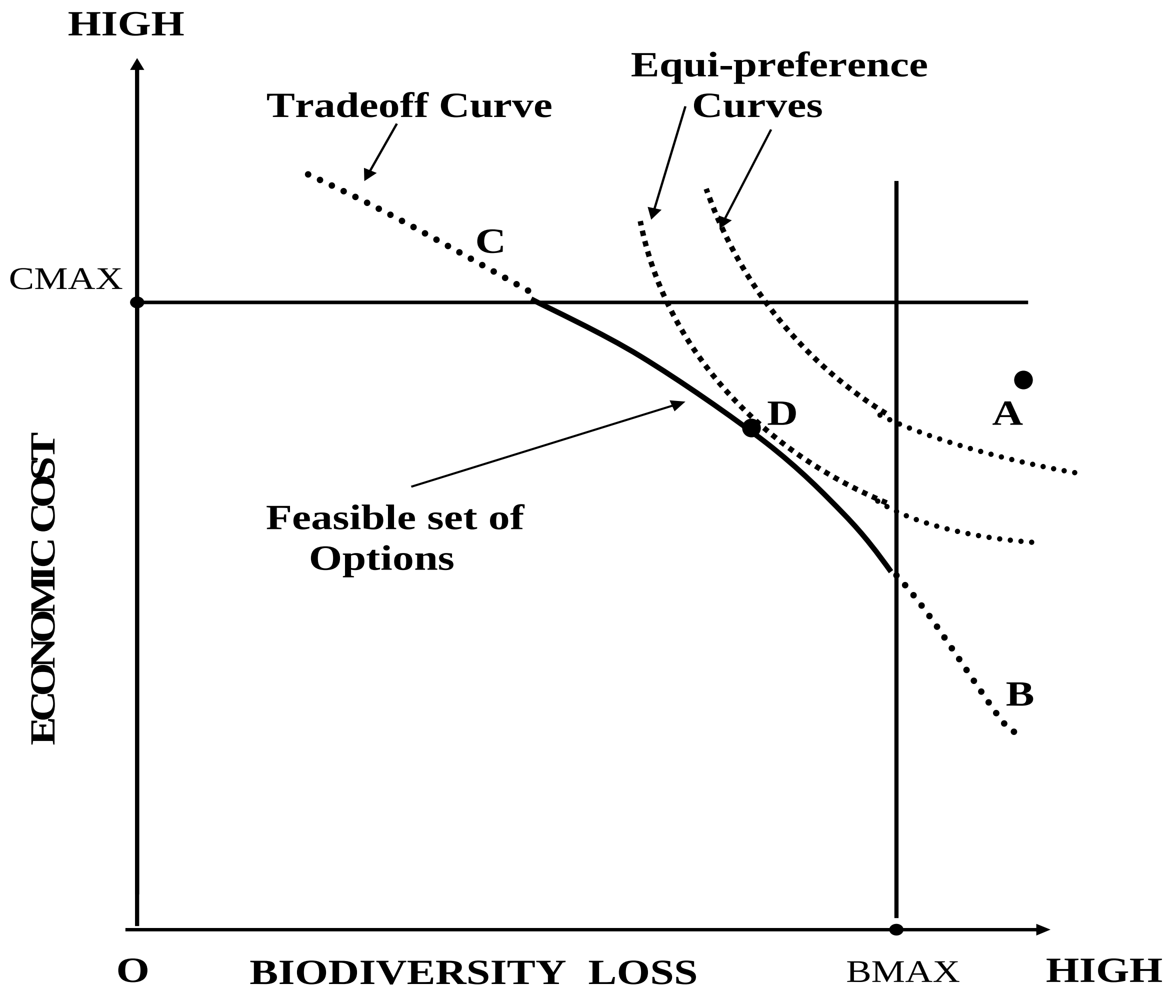
Valuation of multiple, interdependent environmental services across a range of stakeholders, is the most useful, but also more difficult.

	TYPE OF MARKET		
BEHAVIOUR TYPE	**Conventional market**	**Implicit market**	**Constructed market**
Actual Behaviour	Effect on Production Effect on Health Defensive or Preventive Costs	Travel Cost Wage Differences Property Values Proxy Marketed Goods Benefit Transfer	Artificial market
Intended Behaviour	Replacement Cost Shadow Project		Contingent Valuation

Source: Munasinghe (1992), Rio Earth Summit

Simple Multi-criteria Analysis (MCA)

Source: Adapted from Munasinghe (1992).



<u>Project Level Example</u>

Assessing economic, social and ecological indicators for small hydro in Sri Lanka

<u>Primary Source:</u> Morimoto R., and Munasinghe M. (2005) "Small hydropower projects and sustainable energy development in Sri Lanka", *Int. Journal of Global Environmental Issues,* Vol.4.

<u>Summary:</u> Munasinghe, M. (2002) "The sustainomics trans-disciplinary meta-framework for making development more sustainable: applications to energy issues", *Int. J. of Sustainable Dev.*,Vol.4, No.2, pp.6-54.

Overview of study

- Energy affects all three dimensions of sustainable development.
- Reviews linkages between potential impacts of energy production and consumption on sustainable development,.
- Multi-criteria analysis used to assess the role of small hydroelectric power projects in sustainable energy development.
- 3 key variables:

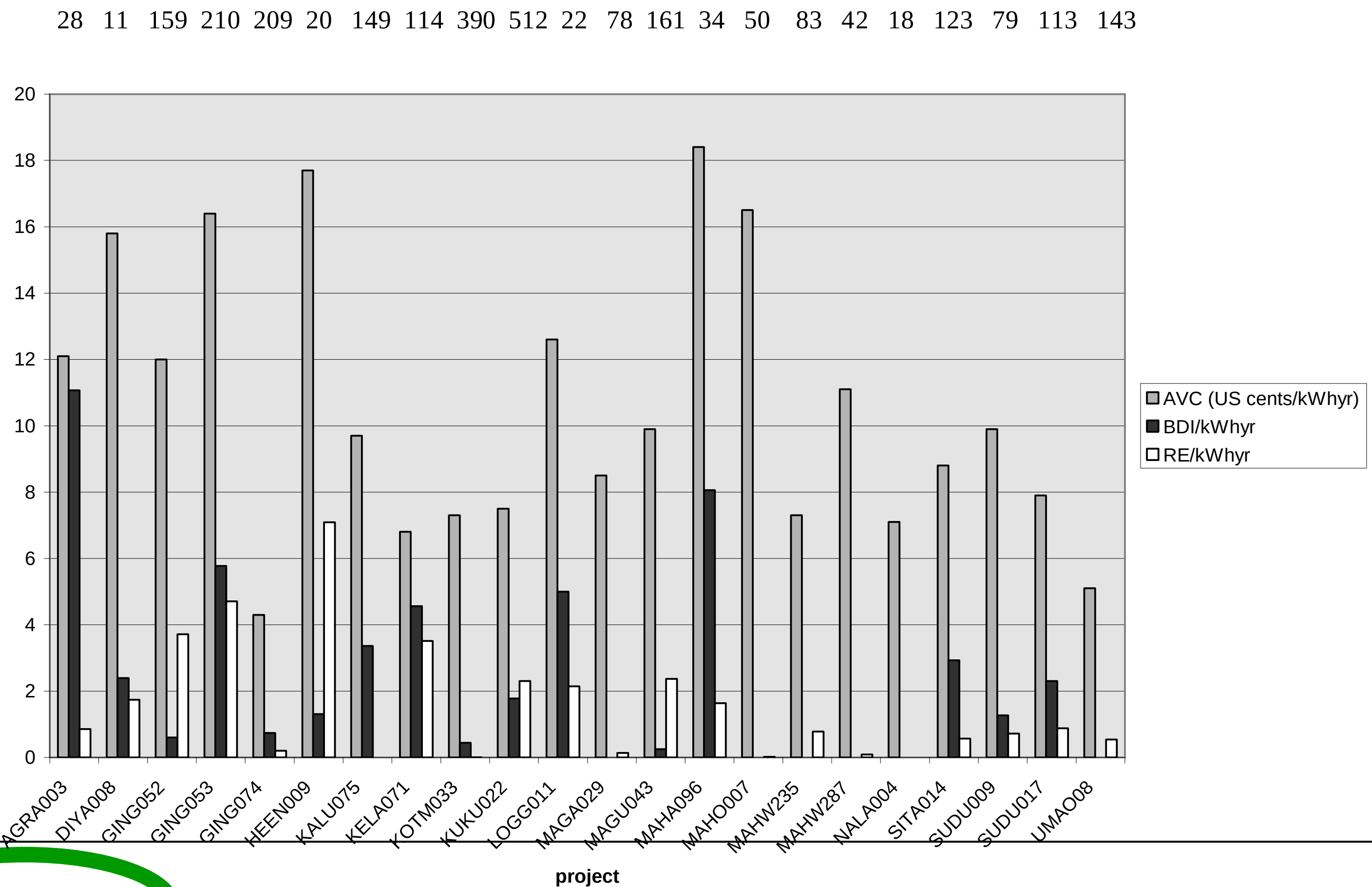
  Economic - electricity supply costs,

  Social - numbers of people resettled,

  Environmental - biodiversity loss
- Analysis helps policy-makers compare and rank project alternatives more easily and effectively.
- The multi-criteria analysis, which includes environmental and social variables, supplements cost benefit analysis which is based on economic values alone.

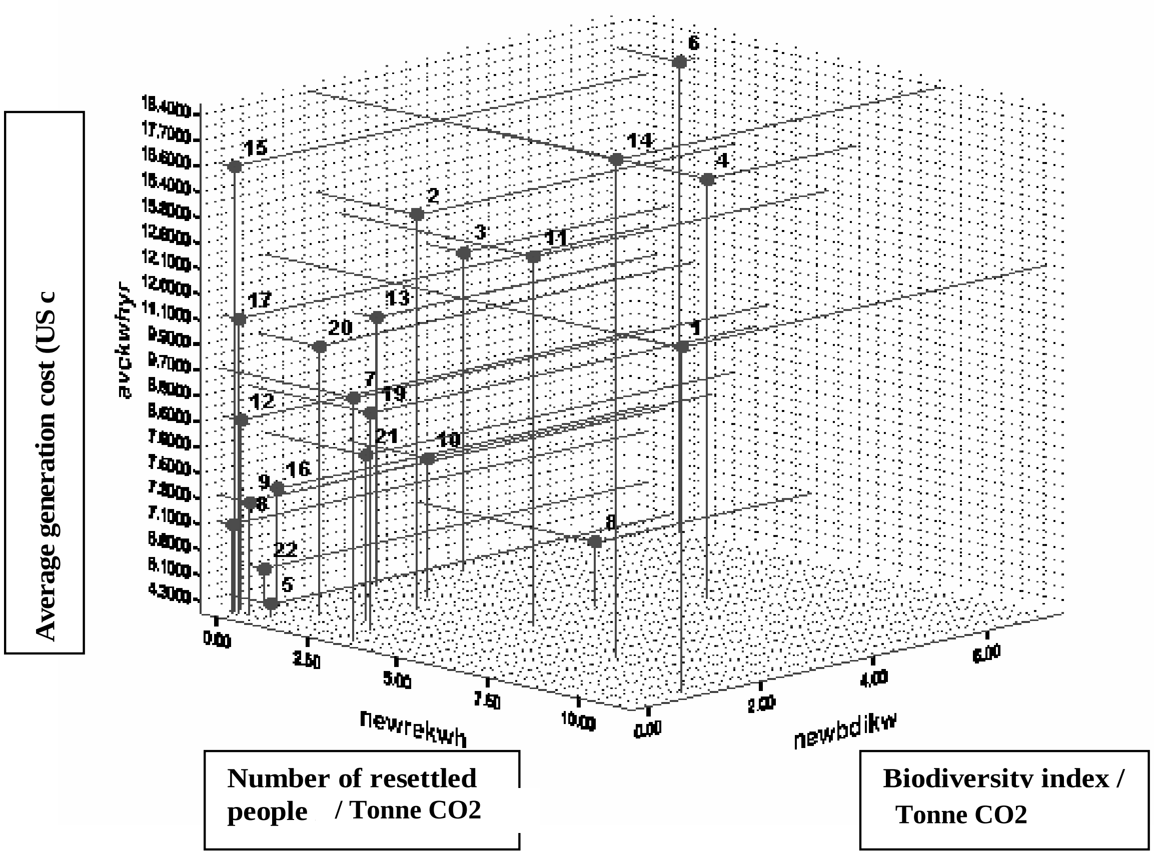
Project Level:
Economic, social and ecological indicators for small hydro in Sri Lanka

Average generation costs (AVC), biodiversity index (BDI), and number of resettled people (RE) by hydroelectric project. All indices may be scaled per tonne of CO2 mitigated per year. Numbers of people resettled and the biodiversity index are scaled for convenience (by the multipliers 10^{-5} and 10^{-9} respectively). Values at the top of the graph indicate the annual energy generation in gigawatt hours (GWh).



Three dimensional MCA of SD indicators of small hydro

Figure 5. Three dimensional MCA of sustainable development indicators for various hydropower options.
Source: Morimoto, Munasinghe and Meier [2000]



Conclusions of Study

- MCA helps policy-makers compare project alternatives more easily and effectively
- Looks at all aspects of project (social, environmental and economic) unlike CBA which emphasises economic aspects.

Linking and Coordinating the Millennium Development Goals (MDG) with Multilateral Environmental Agreements (MEA) & Issues

Misperception: Multilateral Environmental Agreements (MEAs) map into only one MDG

MDGs

- Poverty/hunger
- Primary education
- Gender equality
- Child mortality
- Maternal health
- AIDS, malaria
- Environment
- Global partnership

MEAs

- UNFCCC
- CBD
- UNCCD
- Others

Global Assessments

- •IPCC (climate)
- •MA (ecosystems)

All MEAs & MDGs interact multiply, both ways

MDGs

Poverty/hunger
Primary education
Gender equality
Child mortality
Maternal health
AIDS, malaria
Environment
Global partnership

⇄

MEAs

UNFCCC
CBD
UNCCD
Others

Global Assessments

- IPCC (climate)
- MA (ecosystems)

Misperception: Ecosystems map into only one MDG

MDG

Poverty/hunger
Primary education
Gender equality
Child mortality
Maternal health
AIDS, malaria
Environment
Global partnership

Millenium Ecosystem Assessment (MA)

Freshwater Systems
Marine and Coastal Systems
Forests and Woodlands
Drylands
Island Systems
Mountain Systems
Polar Systems
Cultivated Systems
Urban Systems
Other Systems

All Ecosystems & MDGs interact multiply, both ways

MDG

- Poverty/hunger
- Primary education
- Gender equality
- Child mortality
- Maternal health
- AIDS, malaria
- Environment
- Global partnership

Millenium Ecosystem Assessment (MA)

- Freshwater Systems
- Marine and Coastal Systems
- Forests and Woodlands
- Drylands
- Island Systems
- Mountain Systems
- Polar Systems
- Cultivated Systems
- Urban Systems
- Other Systems

Sri Lanka AIM: Impact of Dev. Policies on Critical Ecosystems

		Critical Ecosystems and Services					
		(1)	(2)	(3)	(4)	(5)	(6)
		Forests	Managed Ecosyst. 1 (grain)	Managed Ecosyst. 2 (tree crops)	Coastal & Marine Systems	Wetlands	Water Resources
	(S) Status	-2	-1	0	-1	-1	-1
Dev. Goals/Policies							
(A)	Growth				-2		
(B)	Poverty alleviation	+2					
(C)	Food Security						
(D)	Employment					+1	
(E)	Trade & Globalisation						
(F)	Budget Deficit Reduction						
(G)	Privatisation						

KEY: 3 = High; 2 = Moderate; 1 = Low; Minus (-) = negative impact/status; Plus (+) = positive impact/status

WHY ? is climate a threat to future human development

Climate Change (CC) undermines Sustainable Development (SD) and unfairly penalizes the poor

HOW ? can we better understand CC-SD links and identify specific issues

Analyze how CC affects SD and vice versa using the Sustainomics framework

WHAT? are the practical solutions and policy options to be implemented that will integrate CC responses into SD strategy (from global to local levels)

Many examples of good practice available.

Improved statistics will play a key role.

Optimistic Take Home Message

Climate change and sustainable development are interlinked problems posing a serious challenge to us all.

Although the issues are complex and serious, both problems could be solved together, provided we begin now.

We know enough already to take the first steps towards making development more sustainable, that will transform the risky "business-as-usual" scenario into a safer and more secure future.

Governance and political systems worldwide must also ADAPT to CC !

Data experts and statisticians can play a key role in the CC-SD transition - mobilising data, identifying & framing the issues, finding solutions, and implementing them.

Ancient Pali Blessing from Sri Lanka about Making Development More Sustainable

"DEVO VASSATU KALENA
SASSA SAMPATTI HETU CA
PHITO BHAVATU LOKO CA
RAJA BHAVATU DHAMMIKO"

"May the rains come in time,
May the harvests be bountiful
May the people be happy and contended
May the king be righteous"

Even in ancient times, a favourable environment, economic prosperity, social stability, and good governance, were well recognised as key factors for making development more sustainable.

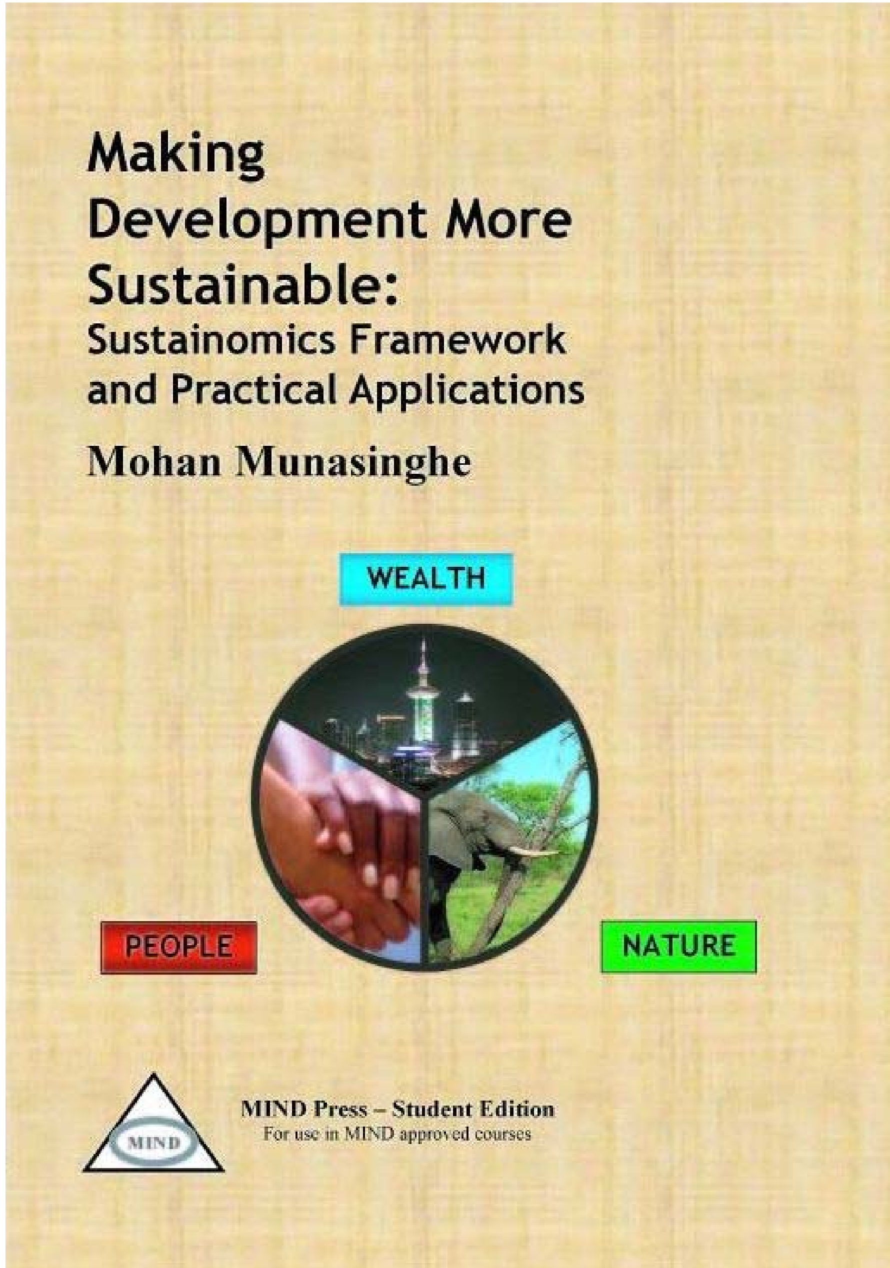
Suggestions for Further Information

1. Munasinghe, M. (2007) *Making Development More Sustainable: Sustainomics Framework and Practical Applications*, MIND Press, Munasinghe Institute for Development, Colombo.

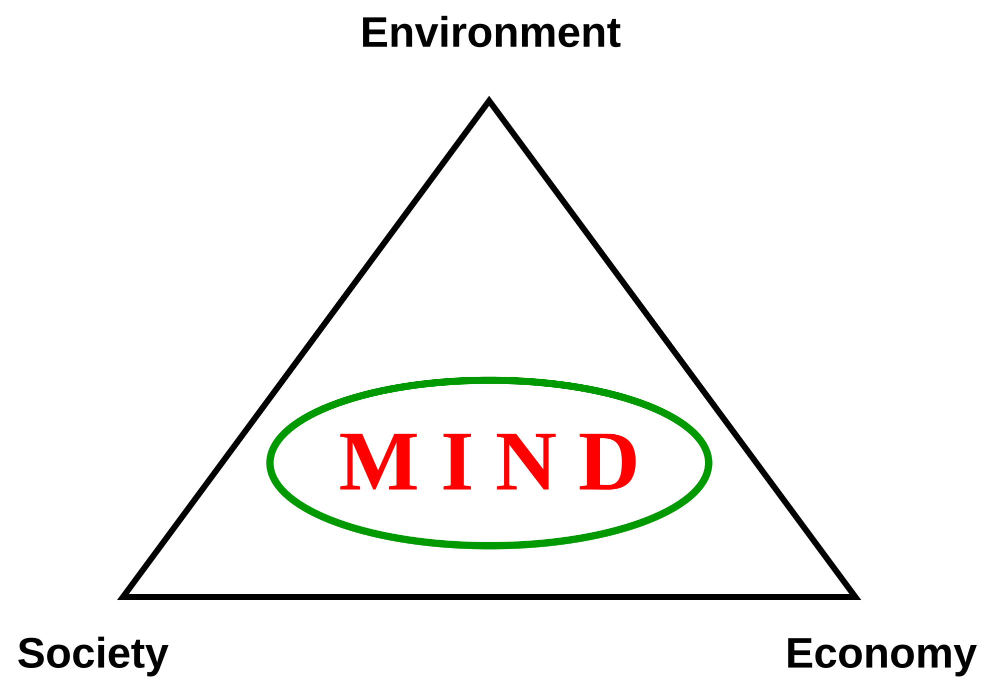
2. Munasinghe, M., and Swart, R. (2005) *Primer on Climate Change and Sustainable Development*, Cambridge University Press, UK. –translated into Chinese

3. MIND (2005) *Action Impact Matrix (AIM) Application to Climate Change - Users Guide*, Munasinghe Institute for Development, Colombo.

4. Website URL: <www.mindlanka.org>


Making
Development More
Sustainable:
Sustainomics Framework
and Practical Applications
Mohan Munasinghe
WEALTH
PEOPLE
NATURE
MIND
MIND Press – Student Edition
For use in MIND approved courses

An Introduction



Munasinghe Institute for Development

"making development more sustainable - MDMS“

10/1 De Fonseka Place, Colombo 5, Sri Lanka
Phone: +9411-255-1208; Fax: +9411-255-1608
E-mail: <MIND@mindlanka.org> ; Web: <www.mindlanka.org>

MIND was established in the new millennium as a private, non-profit organization, to play a key role in nurturing communities of stakeholders and scholars to address major issues of **Sustainable Development (SD)** world-wide. MIND aims to explore viable means of achieving this goal in Sri Lanka and elsewhere without compromising social, economic, and environmental integrity.

MIND PROGRAMMES

- **Awards**

  Research fellowships, Scholarships, MIND Sustainable Support Service (MS3), Book donations

- **Research & Training**

  Training workshops/expert meetings

  Applied research studies and evaluations

  UN "Centre of Excellence" for Asia in the Climate Change Capacity Development (C3D) network of the United Nations Institute for Training and Research (UNITAR).

MIND CC-SD Training Course, CMA, Beijing, July-Aug, 2006
270 Senior Chinese Officials

MIND SD Course, Delhi, Feb. 2007

25 Senior Indian Civil Service Officers

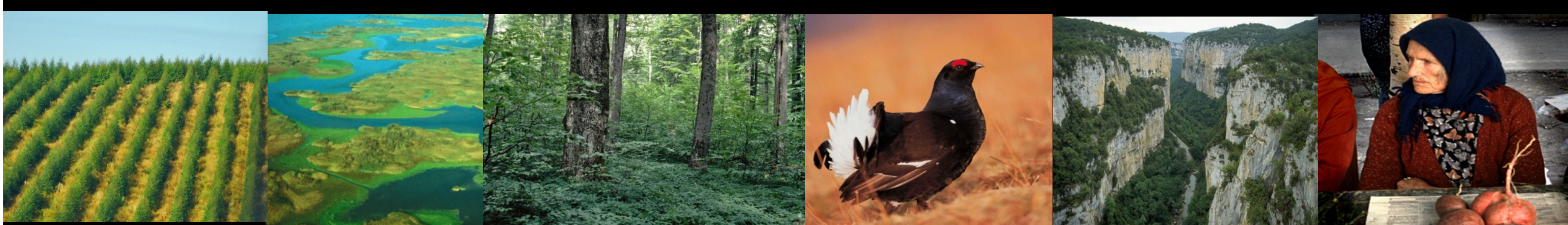
SD Full Course, FES, Yale University, New Haven, 2004-5

24 Graduate Students

Thank You Very Much

The need for better statistics for climate change policies

Jacqueline McGlade
European Environment Agency

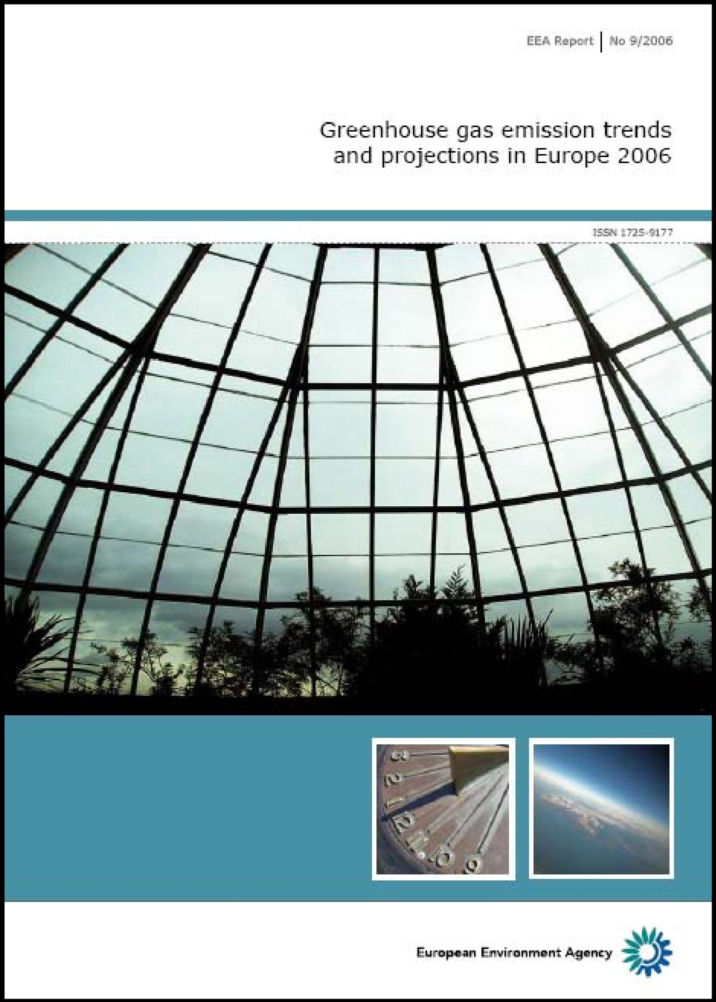


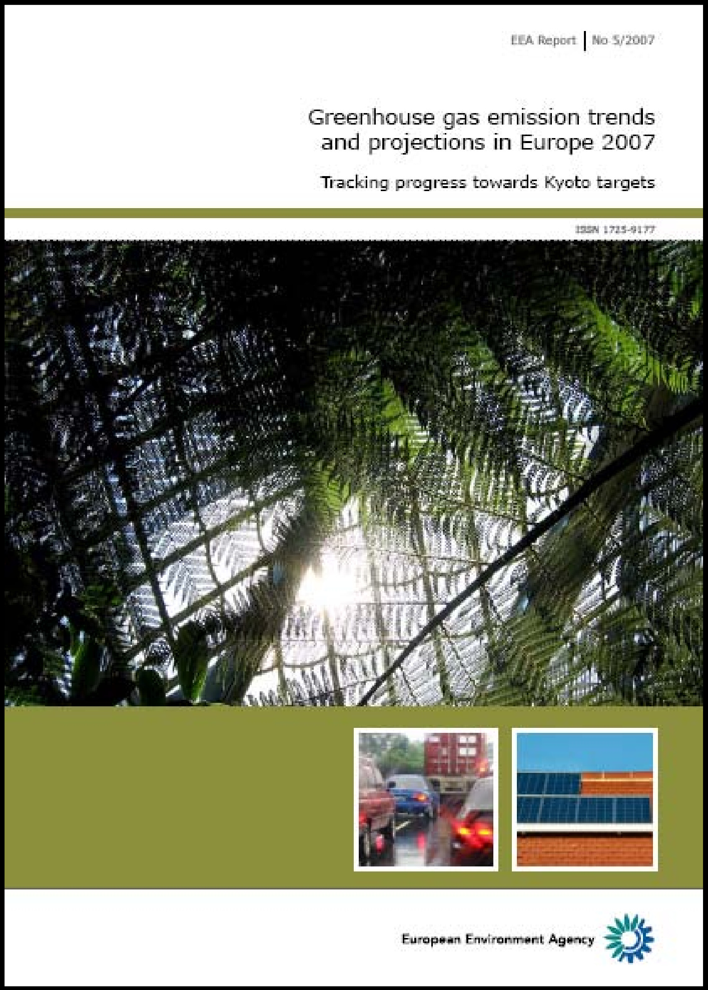
Greenhouse gas emission data: more timely and more spatial data needed

UN Conference on Climate Change and Official Statistics 14-16 April 2008

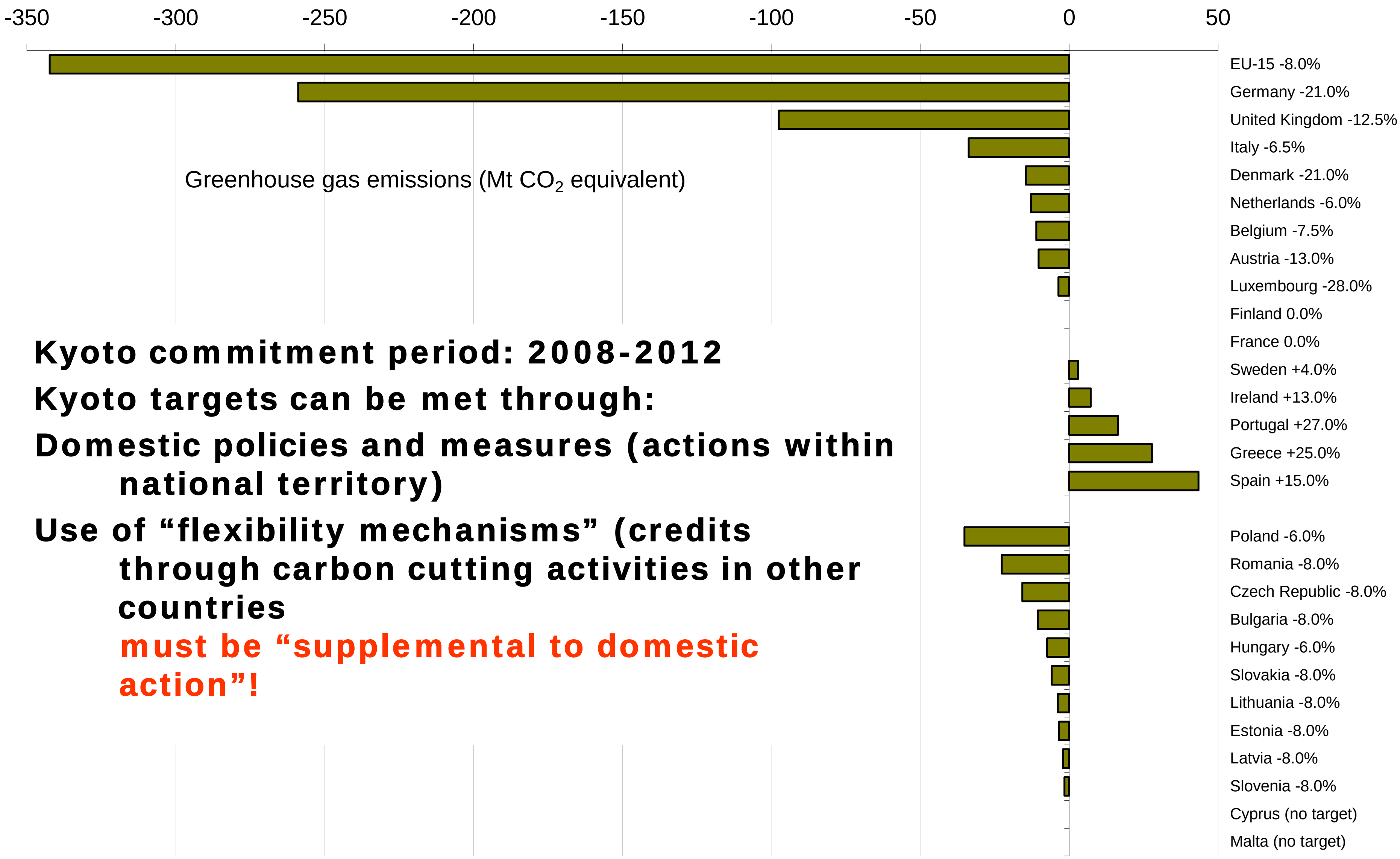
European Environment Agency

EEA annual report on GHG trends and projections in Europe





Kyoto targets in European countries



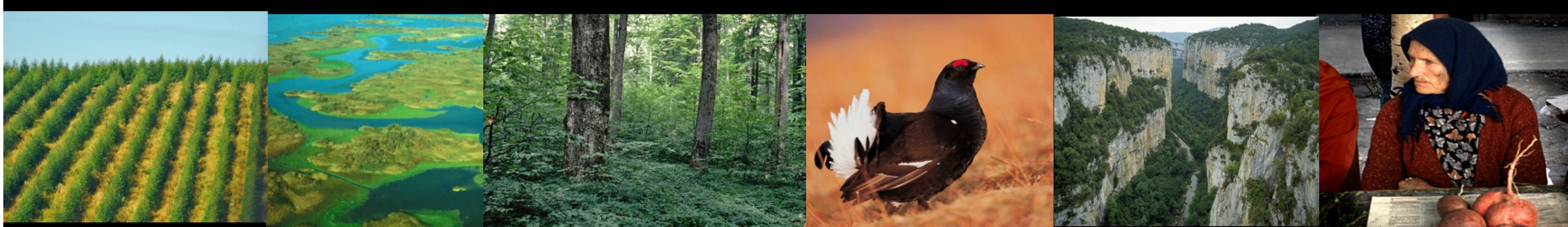
Kyoto commitment period: 2008-2012

Kyoto targets can be met through:

Domestic policies and measures (actions within national territory)

Use of “flexibility mechanisms” (credits through carbon cutting activities in other countries
must be “supplemental to domestic action”!

Greenhouse gas emission data: the need for more transparency



UN Conference on Climate Change and Official Statistics 14-16 April 2008

European Environment Agency

NAMEA versus Kyoto Protocol GHG inventories

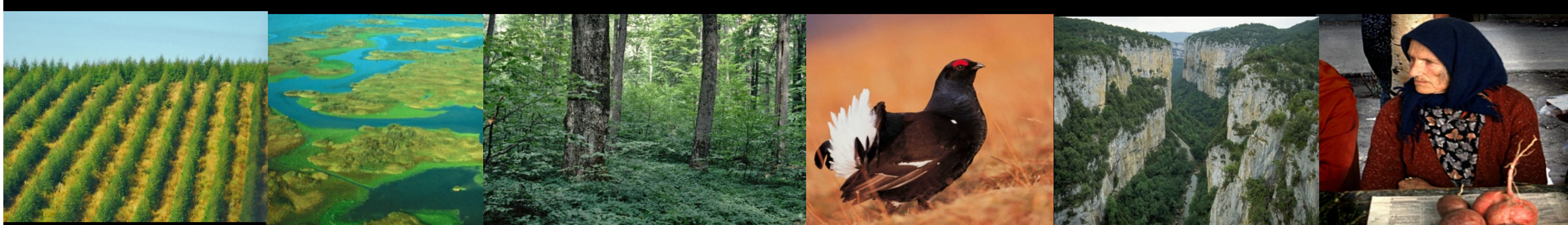
NAMEA

- Measures emissions caused by country's residents and industry in other countries and discounts emissions caused by foreign visits and business to the country
- Includes international aviation and maritime in totals
- Focus is on understanding production and especially consumption patterns inside and outside country

Kyoto Protocol GHG inventories and accounting

- Measures emissions within national boundaries
- International aviation and maritime not included in totals, but as memo item
- Full Kyoto accounting combines GHG inventory data with data on use of Kyoto mechanisms (CDM, JI) and carbon sinks
- Focus is on understanding progress to Kyoto targets

EU Emission Trading Scheme is changing needs

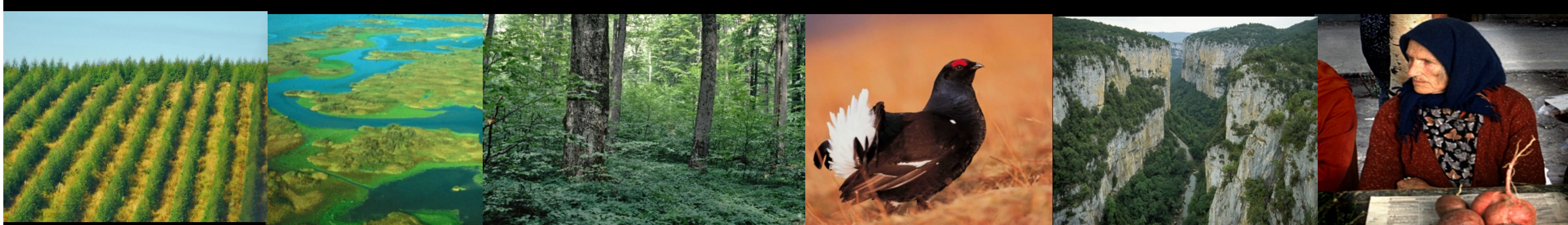


Need for data on Kyoto mechanism projects

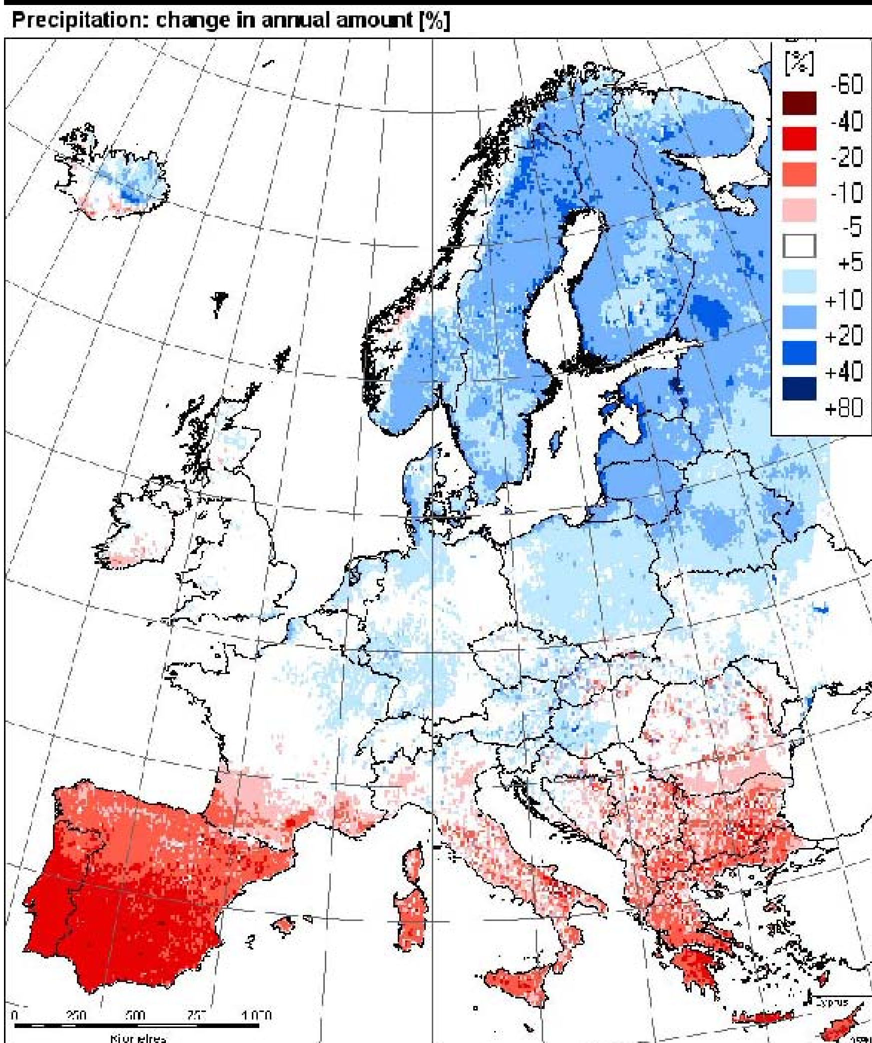
Projected use of Kyoto mechanisms (CDM, JI) by 12 EU MS is about 2.5% of -8% target (107.5 Mt)

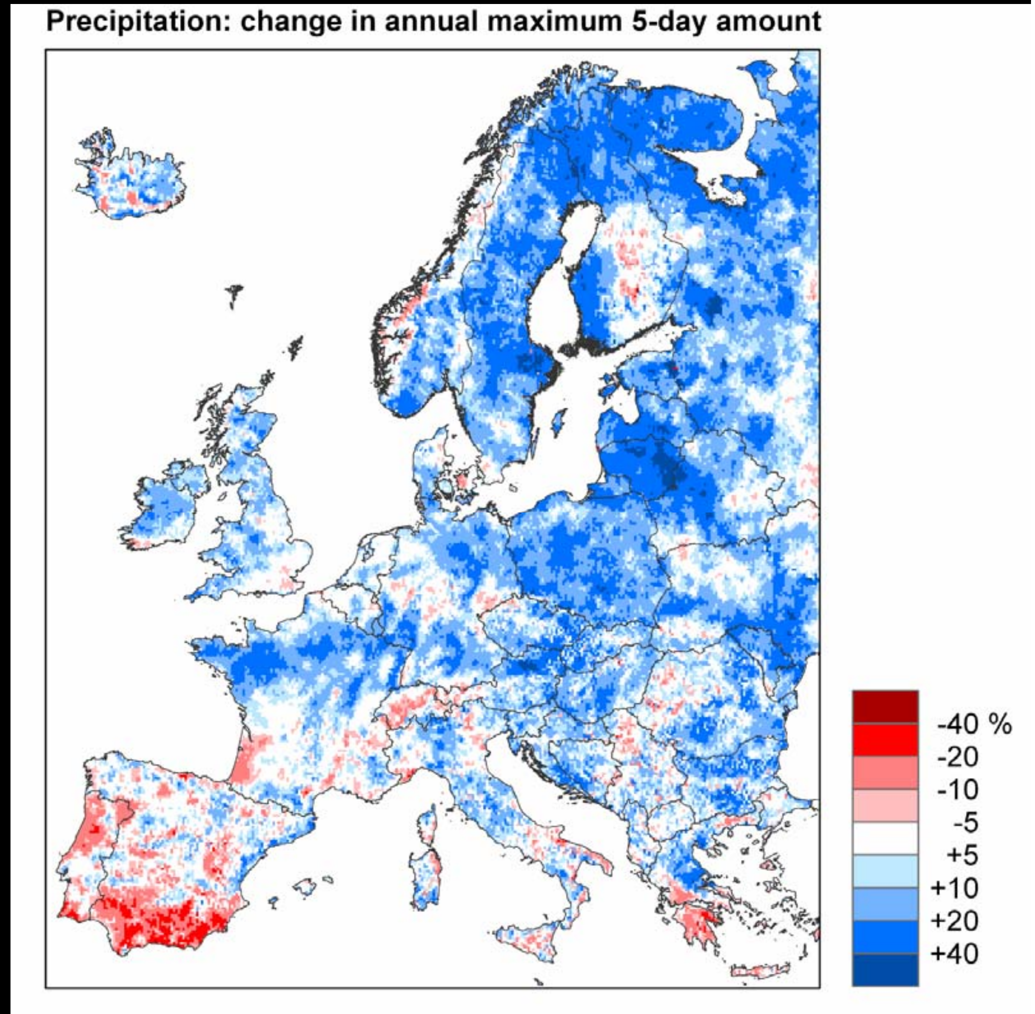
Member State	Planned use of Kyoto mechanisms by government to meet its burden sharing target	Projected emission reduction 2008–12 [Million tonnes CO_2-equivalents per year]	Allocated Budget [EUR million]
Austria	Yes	9.0	319
Belgium	Yes	7.0	104
Denmark	Yes	4.2	152
Finland	Yes	2.4	120
Germany	No	-	23
Ireland	Yes	2.4	290
Italy	Yes	19.0	170
Luxembourg	Yes	4.7	300
Netherlands	Yes	20.0	693
Portugal	Yes	5.8	354
Spain	Yes	31.8	310
Sweden	Yes	(1.2)[a]	25
EU-15	**Yes**	**107.5**	**2 860**
Slovenia	Yes	< 0.6	-

Vulnerability and adaptation data needs

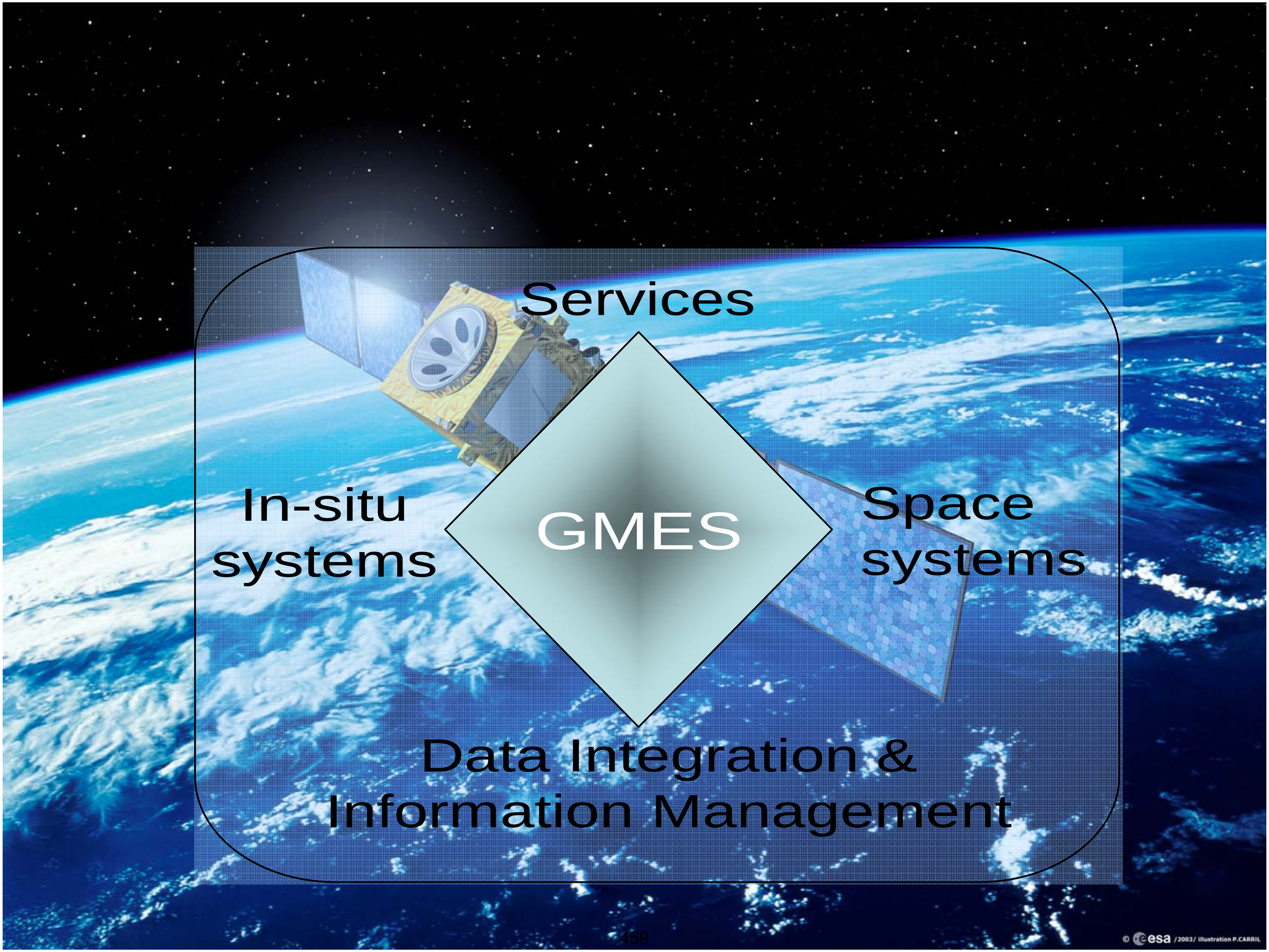


Precipitation projected to increase in northern, decrease in southern Europe; more frequent droughts and floods likely





Source: PESETA project, PRUDENCE; IPCC SRES A2 high emission scenario (change 2071-2100 relative to 1961-1990)


Services
In-situ systems
GMES
Space systems
Data Integration &
Information Management

From stand-alone data to integration

The Rhine Catchment
Area: ca. 180,000 km²

Countries Switzerland, Austria, France. Luxembourg, Germany, Netherlands

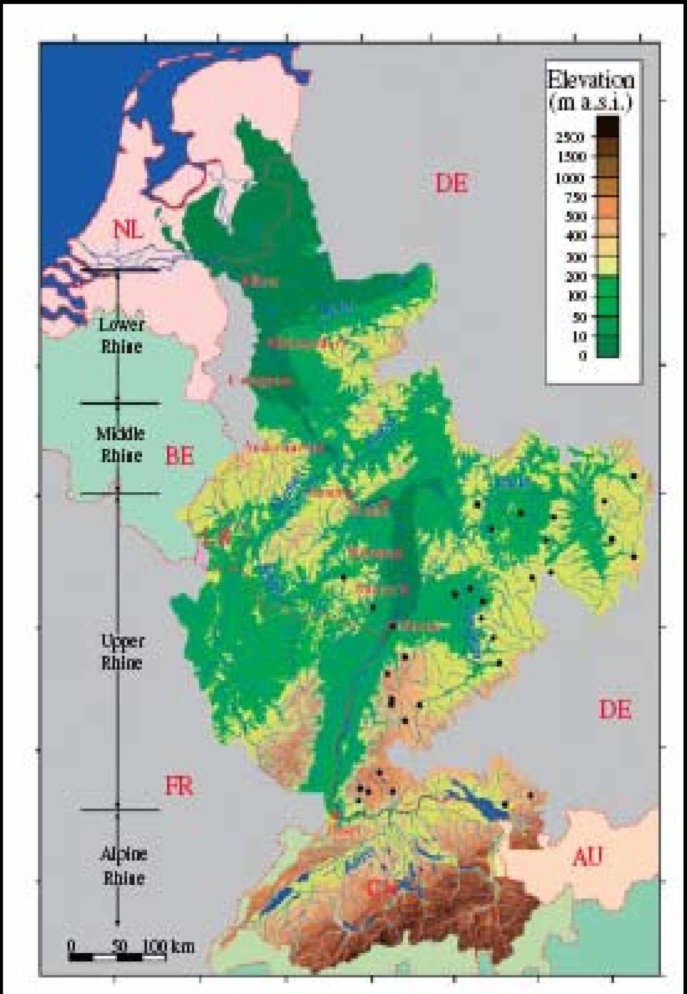
Hydrological Characteristics

Alpine Rhine mainly nival & glacial regime

Floods in late spring / early summer

middle + lower Rhine mainly pluvial regime

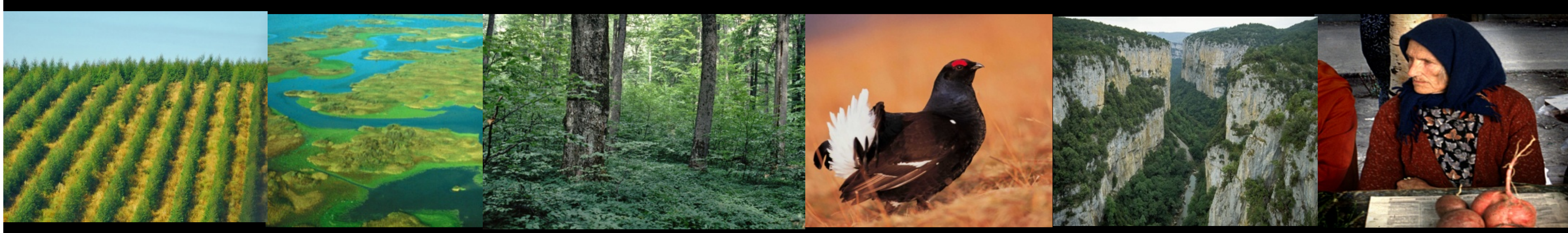
Floods in winter and spring



Ecosystem accounting can help climate change vulnerability assessments

Extensive forests of the Dinaric Alps, Slovenia Photo: E Habic

Conclusions



Statistics Finland

Official statistics as data sources for national greenhouse gas inventories - classification issues and quality requirements

International Conference on Climate Change
and Official Statistics,
14-16 April 2008, Oslo, Norway

Riitta Pipatti

Statistics Finland

Contents

- National greenhouse gas inventories
  - reporting requirements, principles and quality management
- Finland’s national greenhouse gas inventory system
  - data collection - role of statistical information
  - examples on specific issues by sectors
- Current data needs and role of statistics
  - harmonisation of classifications, data collection and timetables
- Future data needs of the UNFCCC and IPCC processes
- Conclusions

Statistics Finland

National greenhouse gas inventories

- **Reporting requirements**
- Submissions to
  - UNFCCC, Kyoto Protocol by 15 April each year
  - EC Commission by 15 January preliminary data, 15 March final data -- additional information on indicators
    - strict timelines -- 6 weeks delay ==> loss of eligibility to use Kyoto Mechanisms
    - strict reporting format (Common Reporting Format (CRF) tables, National Inventory Report NIR)
    - strict requirements on methodologies: IPCC guidelines and good practice guidance, which include requirements on QA/QC, uncertainty estimation, etc.

Statistics Finland

National greenhouse gas inventories

- **Legal, institutional and procedural requirements**:
  - National systems under Article 5, para 2 of the Kyoto Protocol (Guidelines, Decision 19/CMP.1)
    - to ensure capacity (resources, competence) for timely performance meeting the reporting requirements (Art. 7)
    - mandatory - reviewed in the context of the Initial report under the Kyoto Protocol
  - Quality management - continuous improvement; tiered approach; certain QC/QA measures mandatory (IPCC Tier 1)
- **UN Fundamental Principles of Official Statistics and European Statistics Code of Practice** :
  - aim largely to the same goal; differences in scope, detail and terminology

Statistics Finland

National greenhouse gas inventories

- **General requirements/inventory principles**
  - **transparency** (CRF tables, National Inventory Report)
  - **consistency** (time series - recalculations; consistency among sectors/categories)
  - **comparability** (among Parties of the UNFCCC)
  - **completeness**
  - **accuracy** (no systematic over/underestimation; uncertainties reduced as far as practicable)

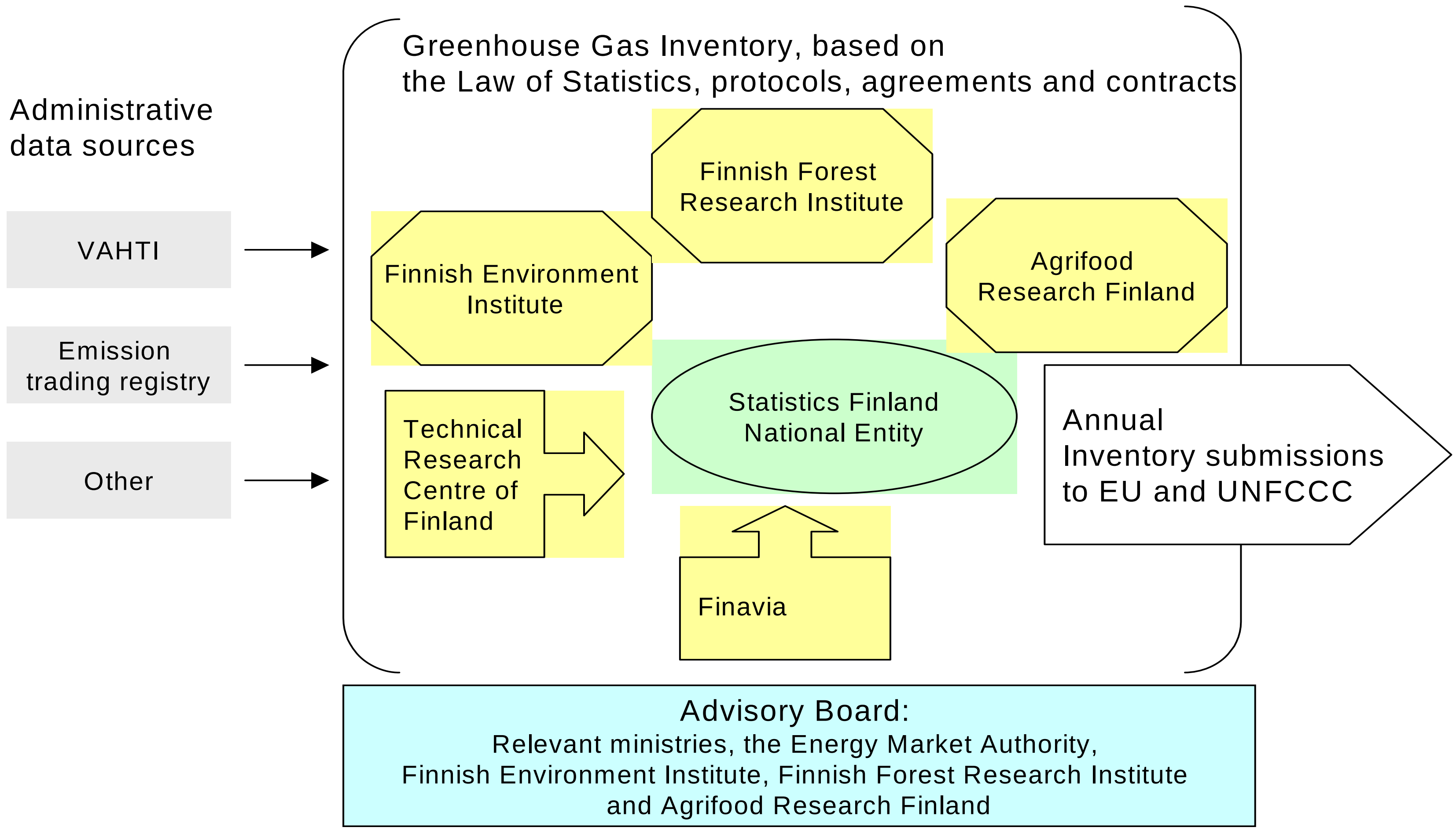
Statistics Finland

Finland’s National System

- Statistics Finland - national entity with overall responsibility since 2005
  - Statistics Act: access to administrative data
  - established procedures for data processing incl. confidentiality, verification and validation of data
  - Greenhouse Gas (GHG) inventories in Finland since early 1990s - current system more resources and expertise, more formalised system (detailed agreements and protocols on responsibilities)

Statistics Finland

Finland’s National System



Statistics Finland

Inventory protocols and responsible organisations

- List of protocols
- A. Stationary sources (fuel combustion in point sources, such as power plants, heating boilers, industrial combustion plants and processes)
- B. Mobile sources (transport and off road machinery)
- C. Other fuel combustion (agriculture, households, services, public sector, etc.)
- D. Fugitive emissions from energy production and distribution
- E. Emissions from industrial processes
- F. Emissions of F-gases
- G. Non-methane volatile organic compounds (NMVOC)
- H. Emissions from agriculture (non-combustion emissions)
- I. Emissions from land use and land use change
- J. Emissions from waste treatment
- K. Other emissions

- Responsible organisation
- A. Statistics Finland
-
- B. Technical Research Centre of Finland (VTT), aviation data - Finavia
- C. Statistics Finland
- D. Statistics Finland
- E. Statistics Finland
- F. Finnish Environment Institute
- G. Finnish Environment Institute
- H. Agrifood Research Finland (MTT)
-
- I. Finnish Forest Research Institute, Agrifood Research Finland
- J. Finnish Environment Institute
- K. Statistics Finland

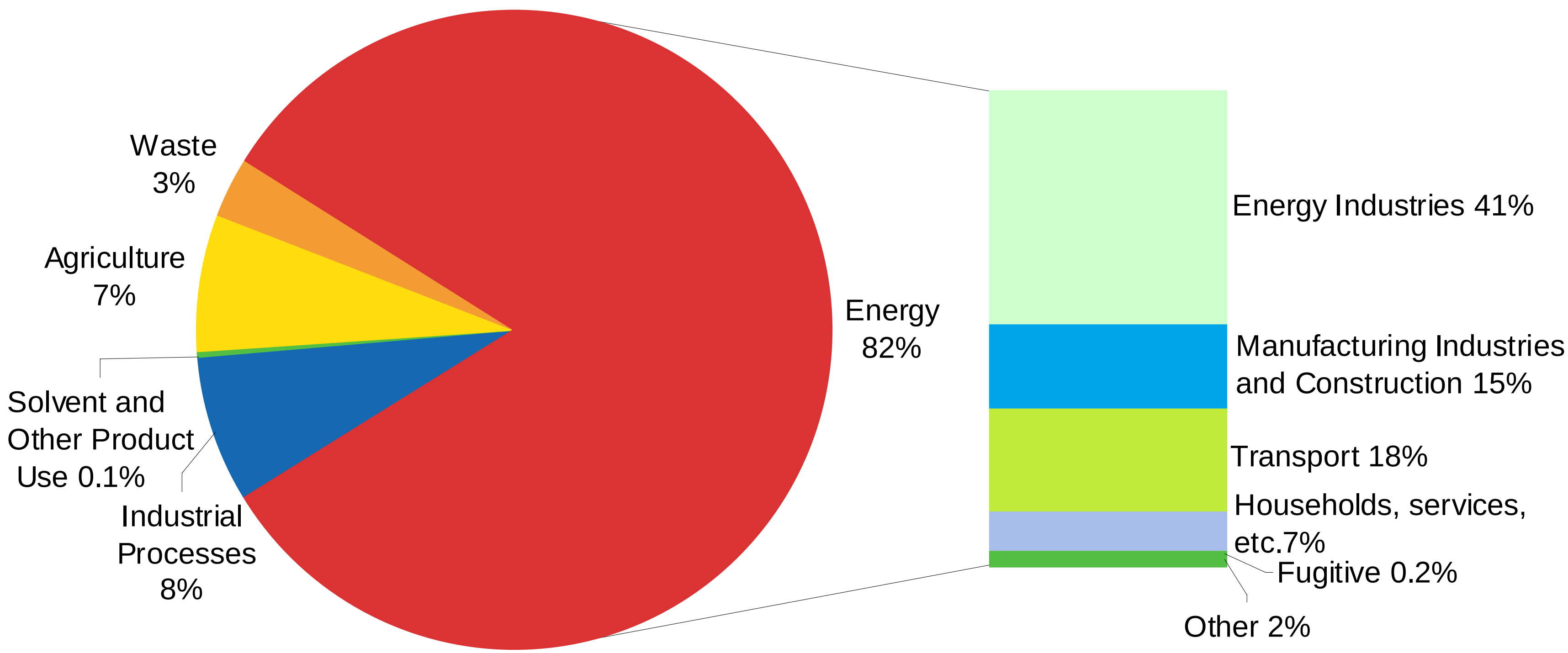
Statistics Finland

Finland's GHG Inventory - Data collection

- Relying mainly on data from the existing statistical system
  - much of the data register-based - several registers, which complement each other, but are not always consistent
    - no gaps allowed in the inventory; EU - gap filling procedure; Kyoto Protocol -adjustments)
    - no overlaps or double-counting of the emissions allowed
    - ensuring completeness and consistency can be resource consuming (e.g. land-use data in Finland)
  - data on F-gases, some industrial processes and peat production areas collected with direct queries (efforts to reduce the burden on data providers)

Statistics Finland

Finland's GHG inventory



Statistics Finland

Finland's GHG Inventory - specific issues on data collection by sectors

- **Energy:** GHG inventory, air pollutant inventory (CLRTAP), energy statistics, EU emission trading scheme (ETS)
  - three organisations -- efforts to reduce overlapping work and to ensure consistency in the outcomes
    - the same fuel classification used by all
    - EU ETS collects data by company or establishment - GHG and CLRTAP inventories by loading point (boiler, process, stack, etc.)
    - confidentiality
    - validation and verification of data

Statistics Finland

Finland's GHG Inventory - specific issues on data collection by sectors

- **Industrial Processes:**
  - the CRF does not follow ISIC/NACE classifications
    - difficult if not impossible to combine data over sectors by branch of industry
  - transparency and comparability vs. confidentiality: plant-specific data cannot be disclosed; less than three companies require grouping of data - calculation of emissions require detailed data
    - reviews - specific modalities for disclosure of confidential data

Statistics Finland

Finland's GHG Inventory - specific issues on data collection by sectors

- **Agriculture**:
  - national statistics give a good basis for the inventory
  - additional data needed on manure treatment (by climate zone), soil data (soil type, management by crop, location) -- 2006 IPCC guidelines will enhance the data needs
    - at present these data are based on research studies, expert opinion etc; the studies are resource consuming and often not representative on national scale
  - Agricultural statistics and GHG inventory: more interaction and collaboration needed

Statistics Finland

Finland’s GHG Inventory - specific issues on data collection by sectors

- **Waste**: uncertainties in the estimates large
  - EU Regulation on Waste Statistics (EC 2150/2002) and the classification system (EWC) have improved the activity data for GHG inventory
    - classification - EWC
      - national improvements - e.g., data collection on composting
    - timing
      - waste statistics available too late for use in national inventory

Statistics Finland

Finland's GHG Inventory - specific issues on data collection by sectors

- **Land Use, Land-Use Change and Forestry**
  - National Forestry Inventory (NFI) - most important data source
    - definitions and land-use classification required by the Kyoto Protocol (based on land cover) differ from those used nationally (based on productivity of forests) and those reported to FAO (land cover and land use)
    - land-use change data -- not collected systematically
  - Kyoto Protocol
    - reporting of geographical location of boundaries of the units of land

Statistics Finland

Current data needs and the role of statistics

- Dialogue and increased collaboration -- the key issue
- Classifications
  - Harmonisation of classifications to the extent possible - aim for a common database -- different needs to be accommodated by aggregation levels
  - Common Reporting Format - conversion of data to accommodate the needs of stakeholders (ISIC/NACE classification)
- Data collection
  - Consistent use of data in statistics and other reporting schemes (coherence)
  - Reduce duplication of work (cost effectiveness, efficient use of resources)

Statistics Finland

Future reporting on CC

- UNFCCC and Kyoto Protocol
  - negotiations for future commitment periods ongoing
  - framework, structure of commitments may change
    - sectoral commitments -- enhanced need of data by ISIC/NACE classification
  - current inventory structure likely to continue (need for simplification?)

  - participation of international statistical community?
  - national GHG inventory => official GHG statistics?

Future input from official statistics to CC

- Official statistics - relevant data for GHG inventories, climate strategy and scenario development, and evaluation of policies and measures
  - development and harmonisation of official statistics
  - energy statistics

Statistics Finland

Future input from national statistics to CC

- Need for additional information
  - sectoral data: indicators to measure performance of abatement measures (comparability of the data)
  - avoided deforestation (remote sensing data, harmonisation of forest inventory methods)

- Importance of dialogue with official statistics and other data providers -- costs, comparability, transparency

Statistics Finland

Thank you!

More information on Statistics Finland and the Finnish National Greenhouse Gas Inventory System at

www.stat.fi and

www.stat.fi/greenhousegases

Reporting and review of GHG inventories under the Convention and the Kyoto Protocol

Conference on Climate Change and Official Statistics

Oslo, Norway 14 - 16 April 2008

Astrid Olsson

Reporting, Data and Analysis Programme

UNFCCC Secretariat

Overview

- Background
- Reporting requirements Annex I Parties
- Non-Annex I Parties reporting requirements
- Review of Annex I Parties' GHG inventories
- Lessons learned
- Statistical data in the reporting and review process

Background (1)

- Requirement in the United Nations Framework Convention on Climate Change for **all** Parties to develop, periodically update, publish and make available to the COP national inventories on GHG not controlled by the Montreal Protocol, using comparable methodologies, as agreed by the COP (Articles 4 & 12)
- The first COP (1995) decided that Annex I Parties shall submit a GHG inventory annually (on 15 April)
- COP 5 (1999) decided that Annex I Parties' GHG inventories shall be reviewed annually
- Kyoto Protocol (Annex I Parties) reporting and review processes build on the Convention, supplementary information to be reported and reviewed
(Articles 5, 7 & 8)
- No reviews of non-Annex I Parties

Background (2)

- Methods agreed by the COP
  - → Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1996)
    - Mandatory for **all** Parties
  - → IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000)
    - Mandatory for Annex I Parties
    - Non-Annex I Parties encouraged to use
  - → IPCC Good Practice Guidance for land use, land-use change and forestry (2003)
    - Mandatory for Annex I Parties
    - Non-Annex I Parties encouraged to use
- 2006 IPCC guidelines
  - → Not adopted under the UNFCCC process
    - Parties can use the available methodologies; need to be justified
    - Have to report in current reporting framework ≠ 2006 IPCC guidelines

Reporting requirements Annex I (1)

- Convention
  - →COP 5 (1999) adopted reporting guidelines on annual greenhouse gas inventories ⇒ Common Reporting Format tables and National Inventory Report
  - →Reporting guidelines updated several times (COP 8 (2002), COP 9 (2003) and COP 11 (2005))
- Principles
  - →**Transparency**: assumptions and methodologies are clear
  - →**Consistency**: all inventory years internally consistent – data/methods
  - →**Comparability**: IPCC methods and UNFCCC reporting guidelines used
  - →**Completeness**: all sources/sinks, gases, years and territories
  - →**Accuracy**: promoted via Good Practice Guidance

Reporting requirements Annex I (2)

- Parties are to report on annual basis (15 April) Common Reporting Format (CRF) tables and a National Inventory Report (NIR)

  →CRF – Data

  - Standardized framework of 40+ tables
  - Almost completely quantitative information
  - Emissions, Activity Data, Implied Emission Factors, Methodologies, Documentation, Recalculations
  - Coverage:
    - Base year to submission year minus two
    - CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 (reported but not reviewed CO, NO_x, NMVOC, SO_2)
    - Cross-sectoral/general; Energy; Industrial processes; Agriculture; Land use, Land-use Change and Forestry; Waste

Reporting requirements Annex I (3)

→National Inventory Report – descriptive report of inventory

- Description of methodologies:
  - Assumptions
  - References of sources, emission factors, activity data and rationale for their selection
- Key categories analysis
- Uncertainties
- Quality assurance/quality control (QA/QC) procedures
- Improvements & changes in response to findings of previous reviews

Reporting requirements Annex I (4)

- Kyoto Protocol
  - → The COP/MOP 1 (2005) adopted Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol which build on Convention reporting
  - → Supplementary information:
    - GHG inventory information, including steps to improve estimates in previously adjusted areas
    - Separated estimates for Article 3, paragraphs 3 and 4, of the Kyoto Protocol activities (KP LULUCF)
    - Information on Art. 3.3 and 3.4 activities (methodologies, location, area, etc.)
    - Information on Kyoto Protocol units
    - Changes in National System
    - Changes in National Registries
    - Information on minimization of adverse impacts in accordance with Article 3, paragraph 14)

Non-Annex I reporting requirements (1)

- Report inventories of GHG in national communication
  - →Requirement for reporting
    - COP 2: Initial National Communication inventory for 1994 (1990)
    - COP 8: (Initial, Second, Third) National Communication inventory for 2000
    - Parties are welcome to report for other years than 1990, 1994 and 2000
  - →Gases (COP 8)
    - Mandatory to report CO_2, CH_4 and N_2O
    - Encouraged to report HFCs, PFCs and SF_6
    - Encouraged to report CO, NO_x and NMVOCs
    - SO_x included at discretion of Parties

Non-Annex I reporting requirements (2)

- Encouraged to :
  - →Use the IPCC good practice guidance
  - →Report on institutional arrangements
  - →Use of reference and sectoral approaches
  - →Report emissions from international bunker fuels (if possible)
  - →Report on methodologies used, including brief explanation on emission factors and activity data used
  - →Provide a key category analysis
  - →Include sectoral tables and worksheets of the IPCC
  - →Provide information on level of uncertainty associated with inventory data

Review process (1)

- Convention
  - →COP 5 (1999) adopted review guidelines
  - →Review guidelines updated at COP 8 (2002)
  - →Purpose of review
    - Ensure that the COP has adequate and reliable information on annual inventories and emission trends
    - Provide the COP with an objective, consistent, transparent, thorough and comprehensive technical assessment of annual inventory information and a technical assessment of implementation of commitments under the Convention
    - Examine in a facilitative and open manner, reported inventory information for consistency with the UNFCCC reporting guidelines and the IPCC Guidelines and good practice guidance

Review process (2)

- Kyoto Protocol
  - → COP/MOP 1 (2005) adopted review guidelines under Article 8 of the Kyoto Protocol
  - → Purpose of review:
    - Establish a process for a thorough, objective and comprehensive technical assessment of all aspects of the implementation of the KP
    - Promote consistency and transparency in the review of information submitted by KP Annex I Parties
    - Assist Parties in improving their reporting of information under Article 7 and implementation of commitments under the KP
    - Provide the COP/MOP and the Compliance Committee with a technical assessment of the implementation of the KP
  - → Critical for Kyoto Protocol – compliance, participation in emissions trading

Review process (3)

- Trial period established for 2000-2002 inventory submissions, extended to 2003 (first reviews conducted in 2001)
- From 2004 mandatory review of all Annex I Parties annually
- 3-stage approach
  - → Initial check ⇒ Status Report
    - Convention: Prepared by secretariat
    - KP: Prepared by expert review teams (ERT)
  - → Synthesis and assessment report, parts I and II
    - Part I approximately 170 tables, across Parties comparisons
    - Part II identification of potential problems for individual Parties, not published on secretariat's web site
    - Both prepared by the secretariat;
  - → Individual review

Review process (4)

→Individual reviews

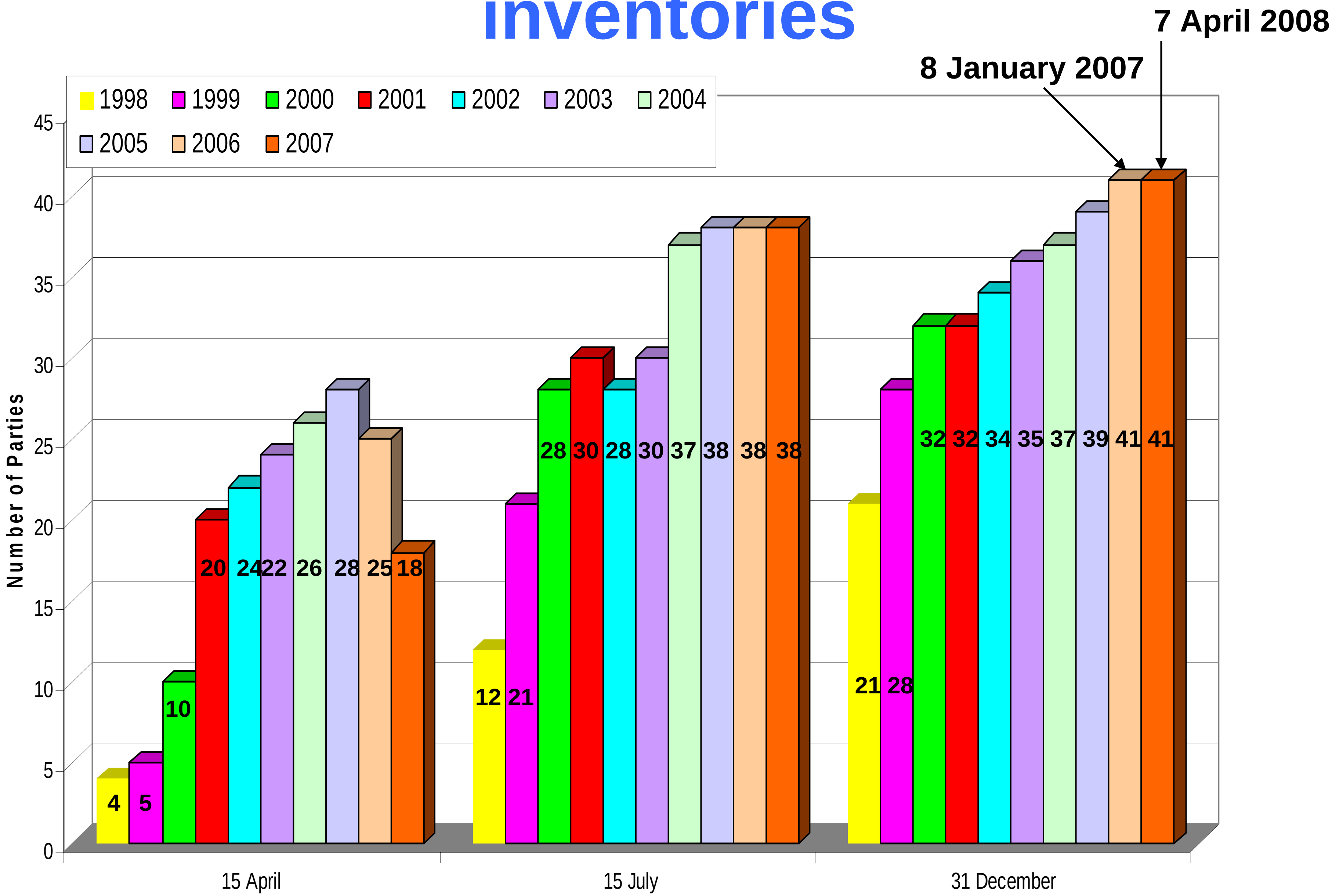
- Experts review teams conduct the review, coordinated by the secretariat
- Desk, centralized or in-country reviews
- In-country review for a Party every 5th year
- Finalization of individual reviews within 3-6 months
- Different time-frames for different review types
- Different time-frames between the Convention and the KP

- Parties get an opportunity to comment all reports, *i.e.* all three review stages, before they are published or provided to the expert review teams

Lessons learned (Annex I Parties)

- ↑ Number of reporting Parties has increased
- ↑ 2006 inventory submissions from all Annex I Parties
- ↑ Quality and completeness of Annex I Parties' inventories have improved over time
- ↑ Review process is a capacity-building exercise for all involved
  - → Party under review
  - → Review experts (non-Annex I and Annex I)
- ↓ Challenges
  - → Timelines for reporting by Parties (availability of activity data)
  - → Timelines in review guidelines, very tight
  - → Availability of review experts

Submissions of annual GHG inventories



Statistical data in reporting and review (1)

- Secretariat uses statistical data from other international organizations in the review process, especially the synthesis and assessment report, parts I and II
  - →International Energy Agency
  - →Food and Agriculture Organization of the United Nations
  - →World Bank
  - →Montreal Protocol
  - →(UN Statistical Division)
- Challenges in comparison with Party data and official statistics
  - →Different definitions used
  - →Different agencies within a country reporting to UNFCCC and other international organizations

Statistical data in reporting and review (2)

- Challenges with official statistics
  - → Confidentiality
  - → Availability of statistics for the first years of the time-series (common for EIT Parties, especially where the geographic coverage of the country has changed)
  - → Definitions of categories
  - → Timeliness of statistical data

Summary

- Reporting requirements different for Annex I and non-Annex I Parties
  - → Strict requirements for Annex I Parties
  - → Requirements for non-Annex I are more flexible
- Reporting of GHG inventories by Annex I Parties has improved
  - → Number of Parties
  - → Quality and completeness
- Review process for Annex I Parties only
- Review process has helped in improving Annex I Parties GHG inventories
- National official statistics play an important role in all countries
  - → Need to be available on time
  - → Definitions need to be the same
- International official statistics used in the review process

Takk!

Thank you !

More information:

www.unfccc.int

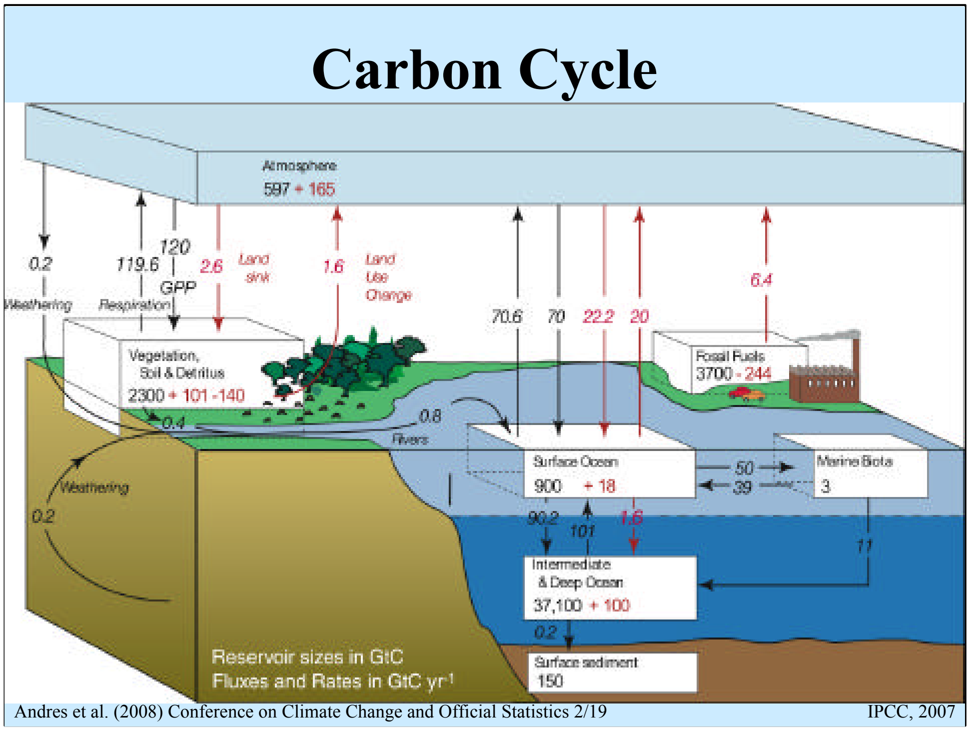
aolsson@unfccc.int

The Use of UN-Supplied Fuel Production and Trade Statistics for the Estimation of Global and National Fossil-Fuel-Derived Carbon Dioxide Emissions

Andres R J[1], **Boden T A**[1], **Marland G**[1, 2]

[1]Oak Ridge National Laboratory
[2]International Institute for Applied Systems Analysis

andresrj@ornl.gov



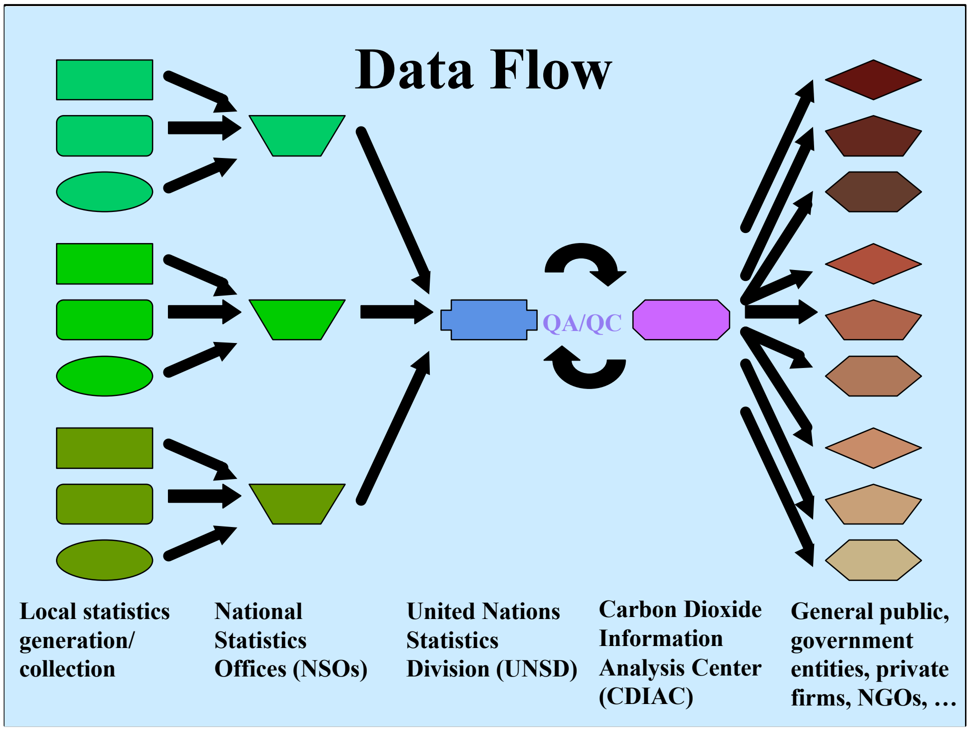
This work was stimulated and is driven today by our increasing awareness of the global carbon cycle and the role it plays in climate change.

Reservoir units, flux units, black (natural) and red (anthropogenic) fluxes.

Carbon dioixde from fossil fuel consumption is not the largest flux in the carbon cycle, but it is the only flux that is not substantially balanced by a counter flux. This is due to the extremely long time scales involved in converting organic matter back into fossil fuels. The result of this imabalance is the quick buildup of carbon in the atmosphere and its subsequent slower redistribution to other sinks in the carbon cycle.

Figure 7.3. The global carbon cycle for the 1990s, pre-industrial ‘natural’ fluxes in black and ‘anthropogenic’ fluxes in red.

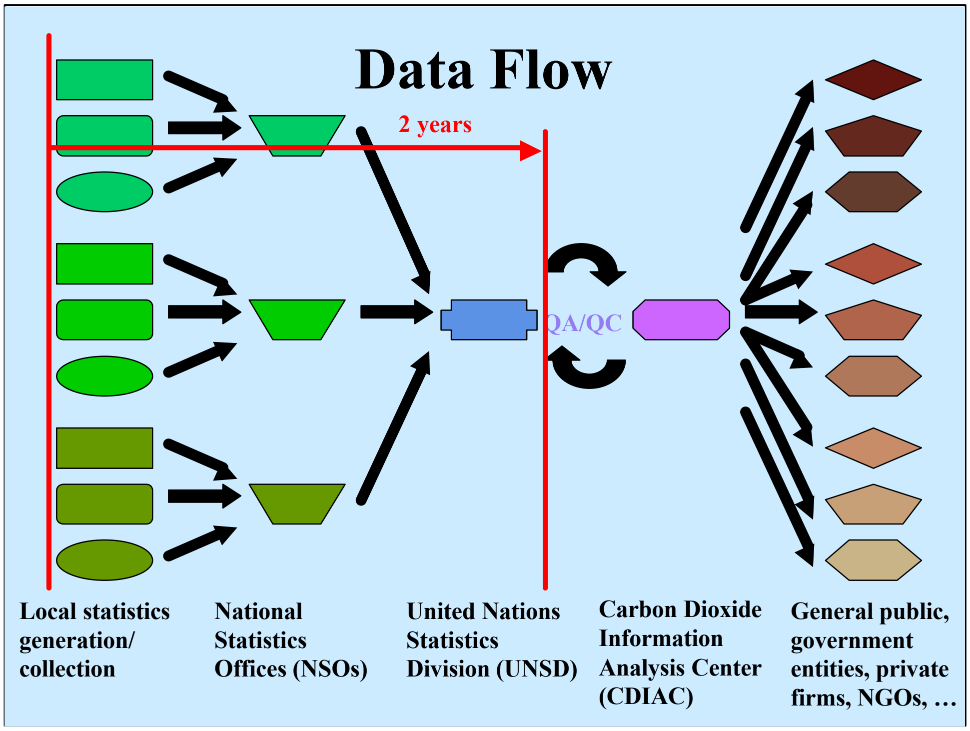
IPCC (2007) Climate Change 2007: The Physical Science Basis. Contributions of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (eds.)). Cambridge: Cambridge University Press. p. 515.



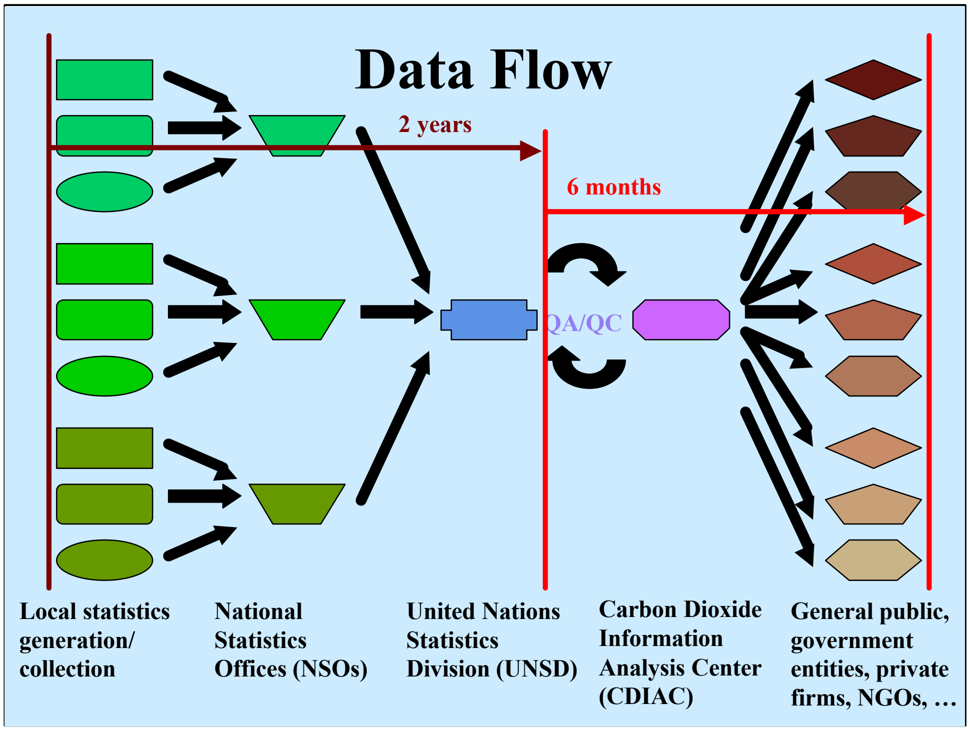
The UNSD energy statistics data set that my group, CDIAC, uses for its fossil-fuel CO2 estimations is a product that results from input from at least two levels of finer resolution.

The basic data flow process is shown in this diagram. As we proceed from left to right, we see that the data is increasingly aggregated and consolidated. At CDIAC, we produce a variety of products that use these CO2 estimates and thus reverses the consolidation trend and distributes the data in a variety of formats useful for the broader community.

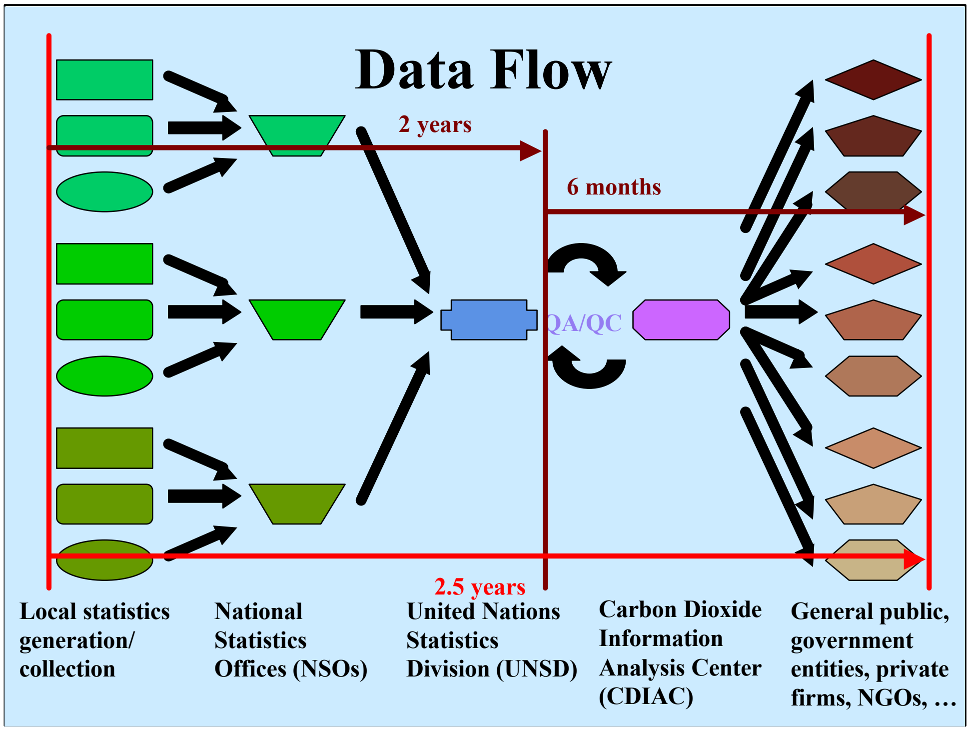
Along the way there may be various types of quality assurance/quality control checks performed. I will briefly focus here on one of these QA/QC steps. In cooperation with UNSD, CDIAC performs a QA/QC check that looks to ensure internal consistency in the UNSD energy statistics which contains more than 2 million individual pieces of data. This interactive process between UNSD and CDIAC has consistently improved the enregy statistic product over the years. It is a fruitful relationship which we plan on continuing into the future. It should be mentioned here that this QA/QC process does not check for the validity of individual values. We, at CDIAC, do not have the resources to independently verify every value in the UNSD-supplied energy statistics.



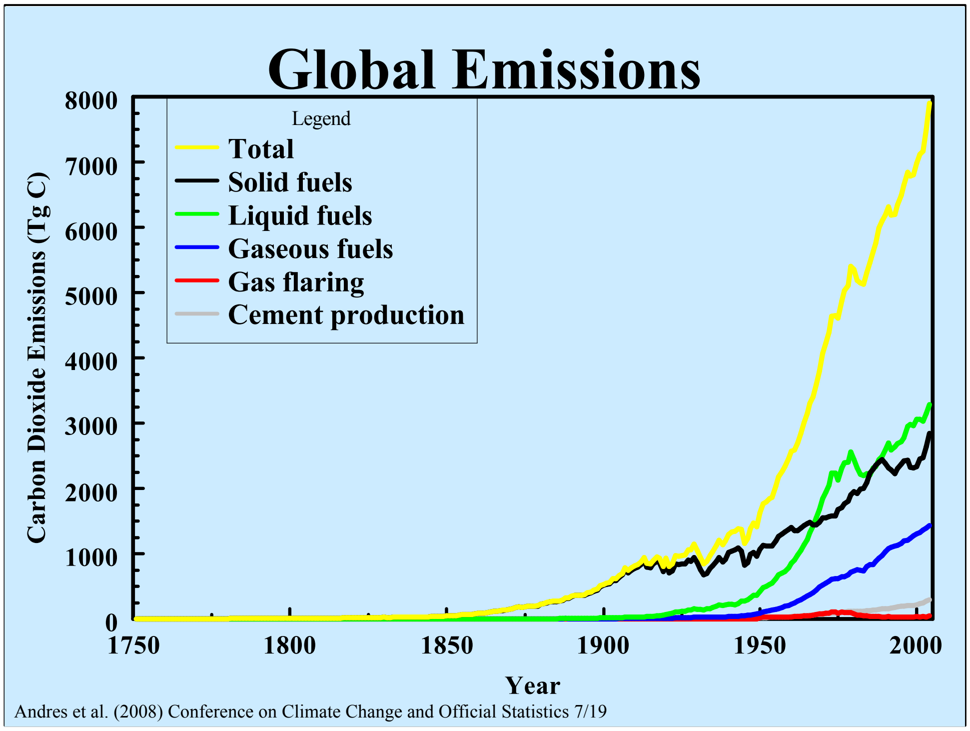
Before moving on, I would like to comment on the time it takes to complete this data flow process. From the close of the calendar year, it takes approximately two years for the data to flow from the left side of the diagram to the point where UNSD relases the data to CDIAC for QA/QC analysis.



For the 2005 year release of the energy statistic data, the QA/QC process is ongoing now. We expect that QA/QC process to be concluded, CO2 estimations completed, and data products readied for general release in the next 6 months.



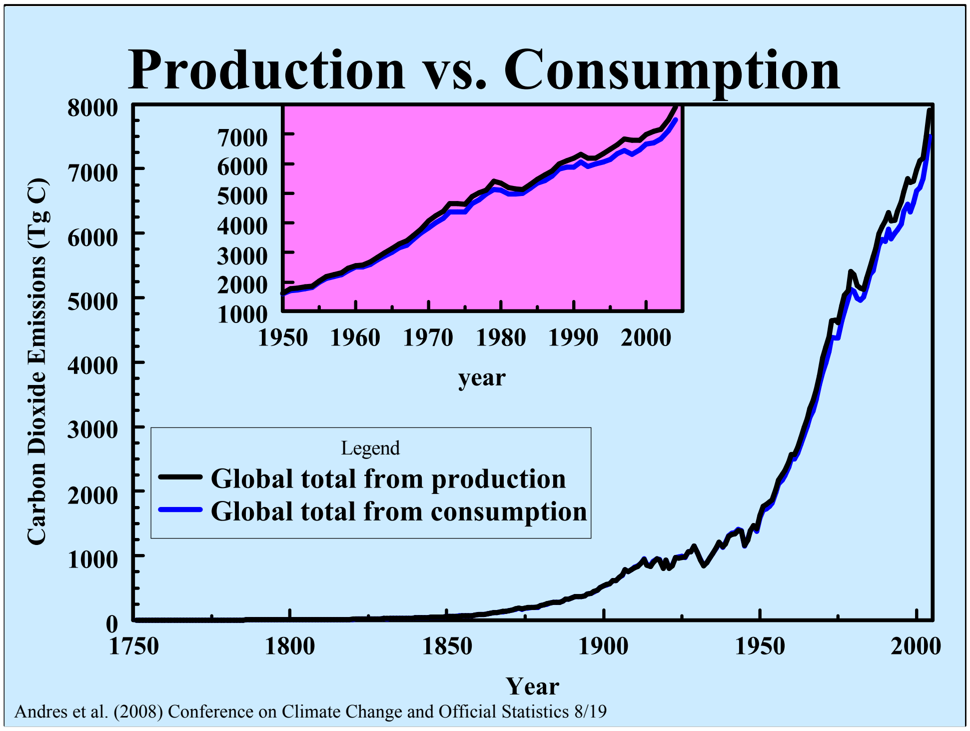
So the total process from left top right takes approximately 2.5 years.



This slide shows one of our first and most accessed data products: the global estimate of CO2 emissions from fossil fuel and cement production.

Here the total has been broken up into its major components: solid fuels, liquid fuels, gaseous fuels, gas flaring, and cement production.

The data go from 1751 through 2004. The pre-1950 data utilize statistics not produced by UNSD. The 1950-present data are based upon UNSD-supplied energy statsitics.

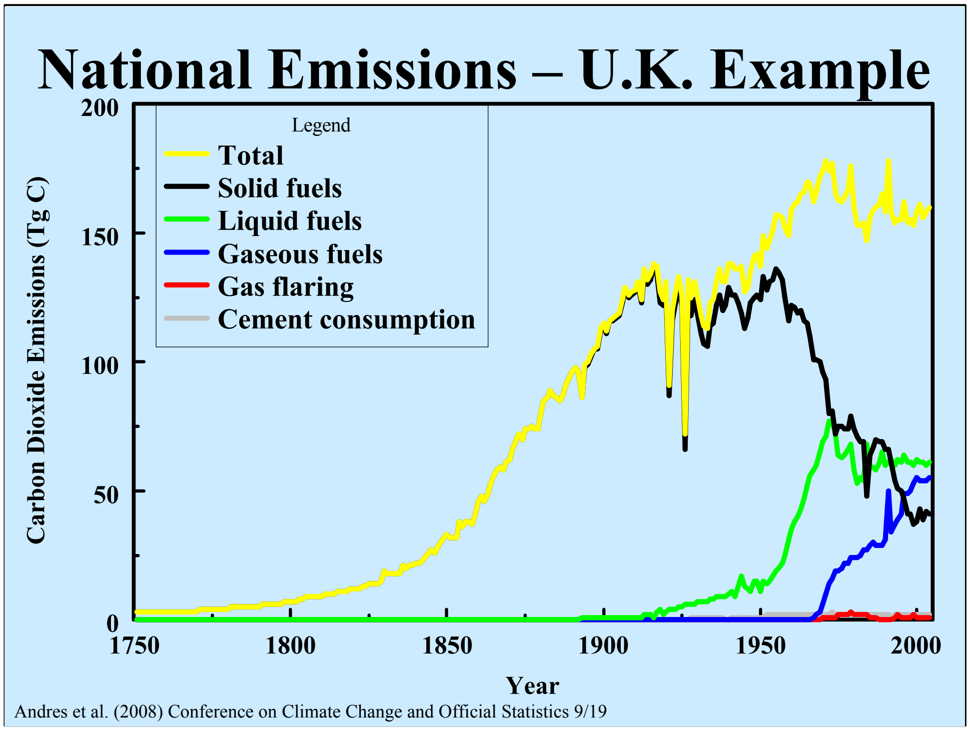


You may have noticed I used the word "production" and not "consumption" in reference to the global totals. That is because the global numbers are based on fuel production statsitics and not fuel consumption statistics. There are many reasons for this which are listed in the manuscript supplied for this conference. Suffice it to say, the production statistics have lower unceratinties associated with them than consumption statistics.

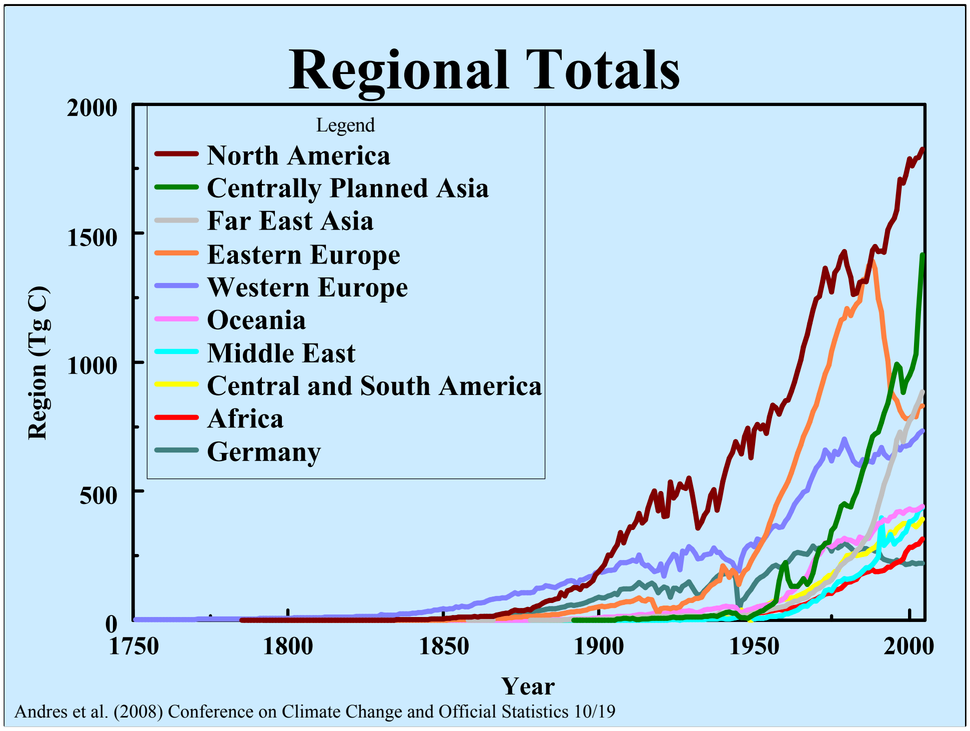
Here we see the global totals based upon production statsitics compared to consumption statistics. At this scale, the two time series seem relatively similar. About half of the difference between the two curves is due to emissions from bunkler fuels. Bunker fuels are those fuels used in international trade and by convention not attributable to any one country.

Production being relatively similar to consumption is not the case at finer spatial scales such as at the national level. National level carbon dioixde emission statistics, another early and commonly accessed CDIAC data product, are based upon consumption statistics. The consumption curve plotted here is the sum of the national totals as derived with national consumption statistics.

The inset is an enlargement of the post-1950 period.

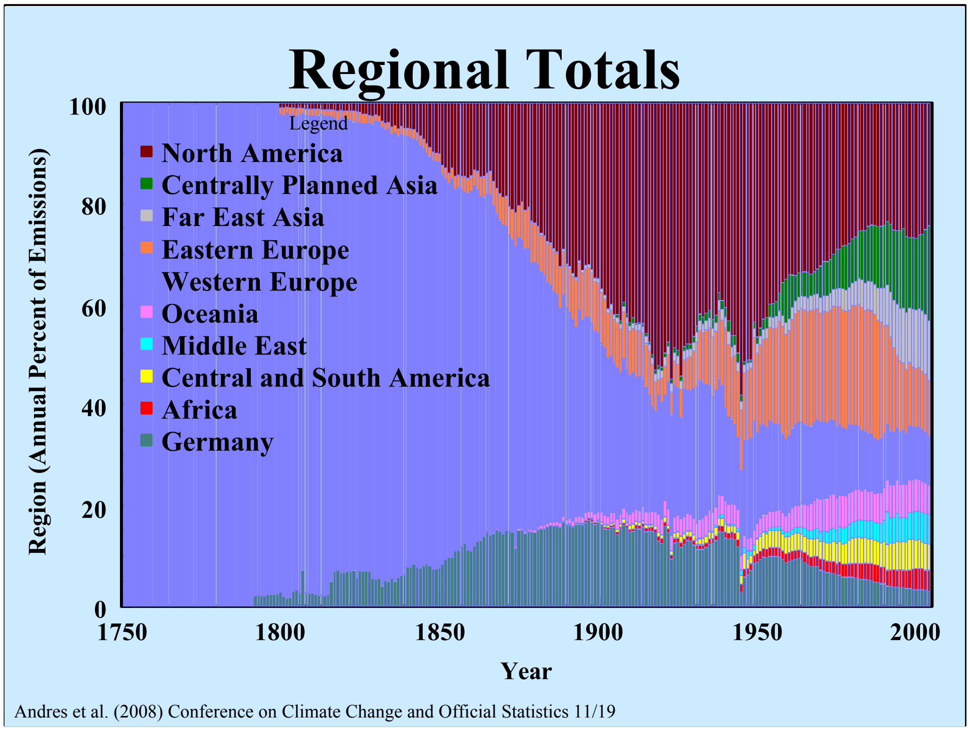


An example of the national consumption data. This is the longest running national time series we have, UK, 1751-present.



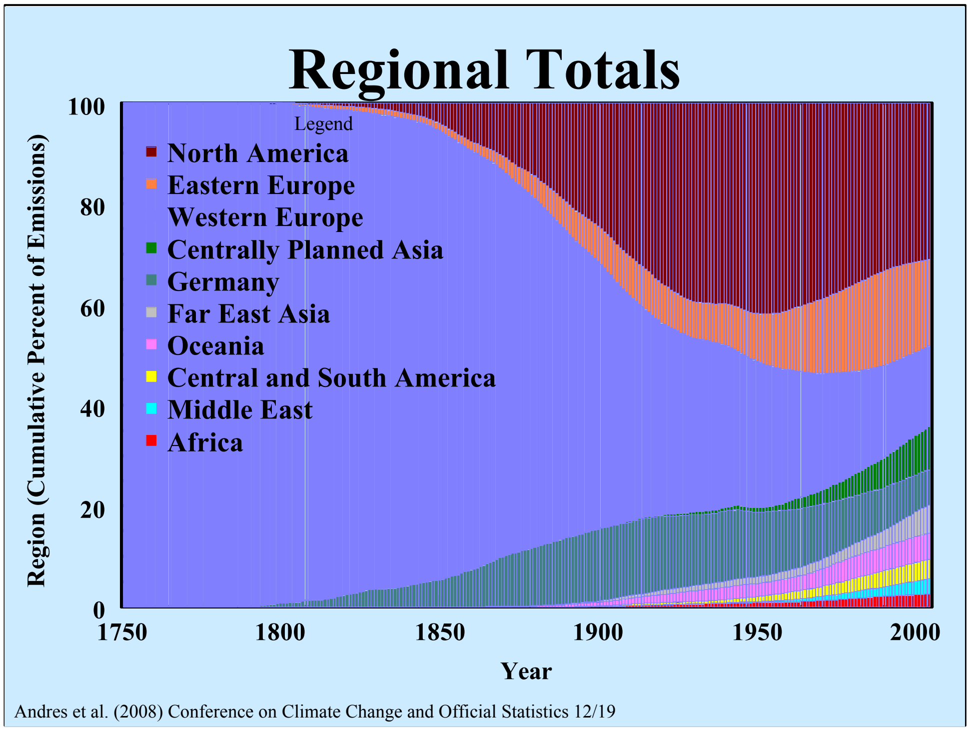
Regional totals are created by adding together emission estimates from nations in certain geographic areas.

Regions ordered in legend by decreasing 2004 totals.



Same totals, except recaluclated by percent of total on an annual basis.

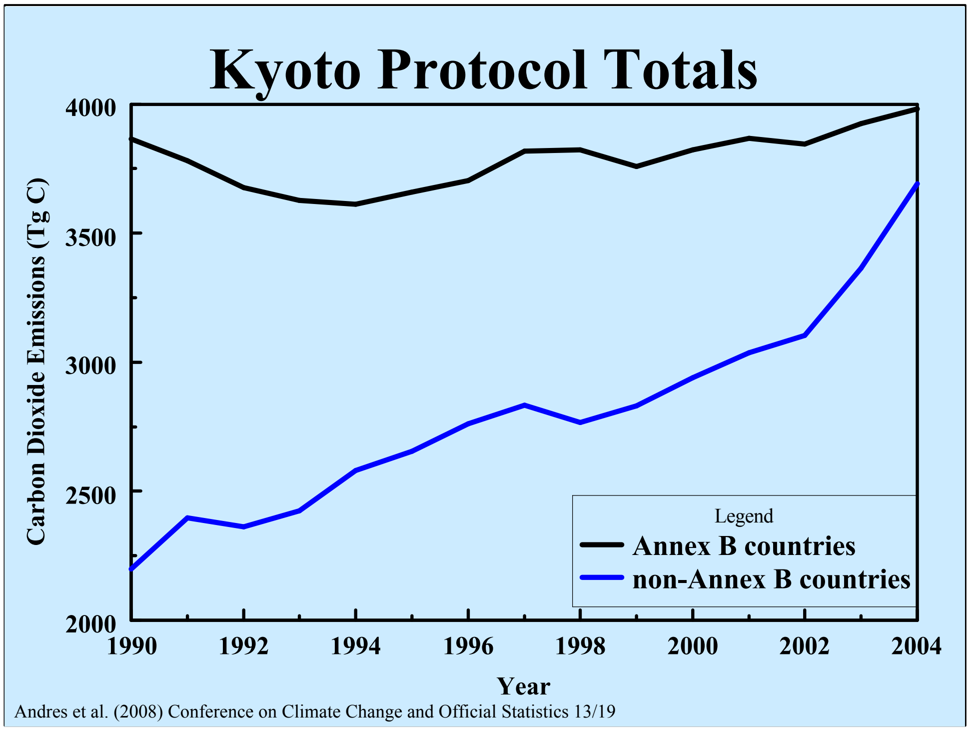
Same colors and legend order as in previous slide.



Regional totals recaluclated by cumulative percent of emissions, 1750-present.

Same colors as in previous slide.

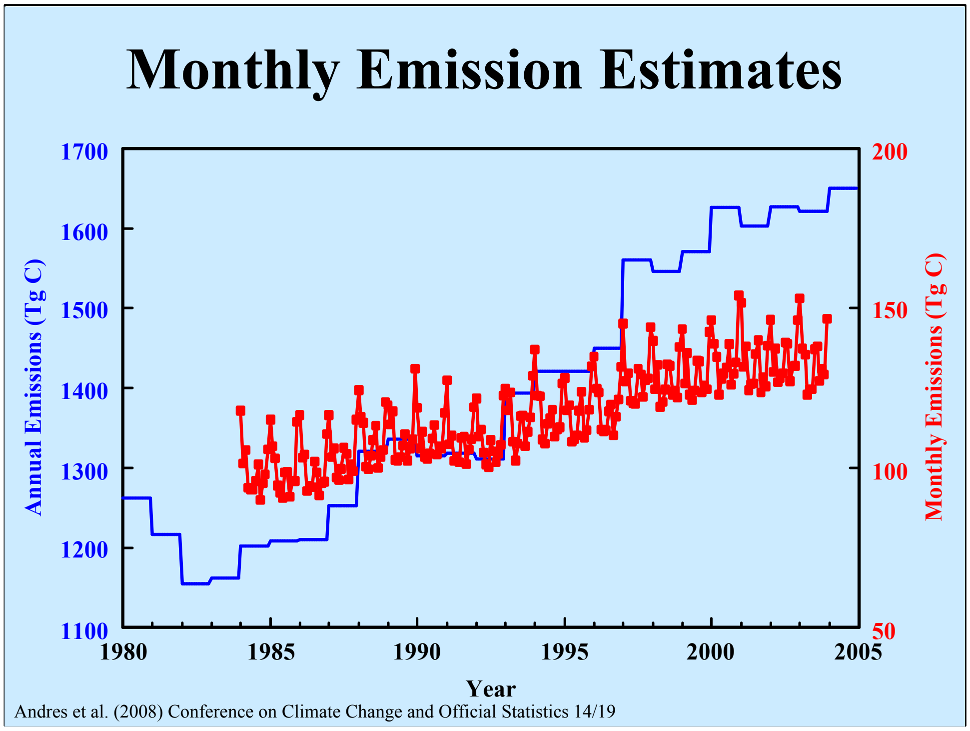
Regions ordered in legend by decreasing 2004 cumulative totals. This is a change in order from the previous two slides.



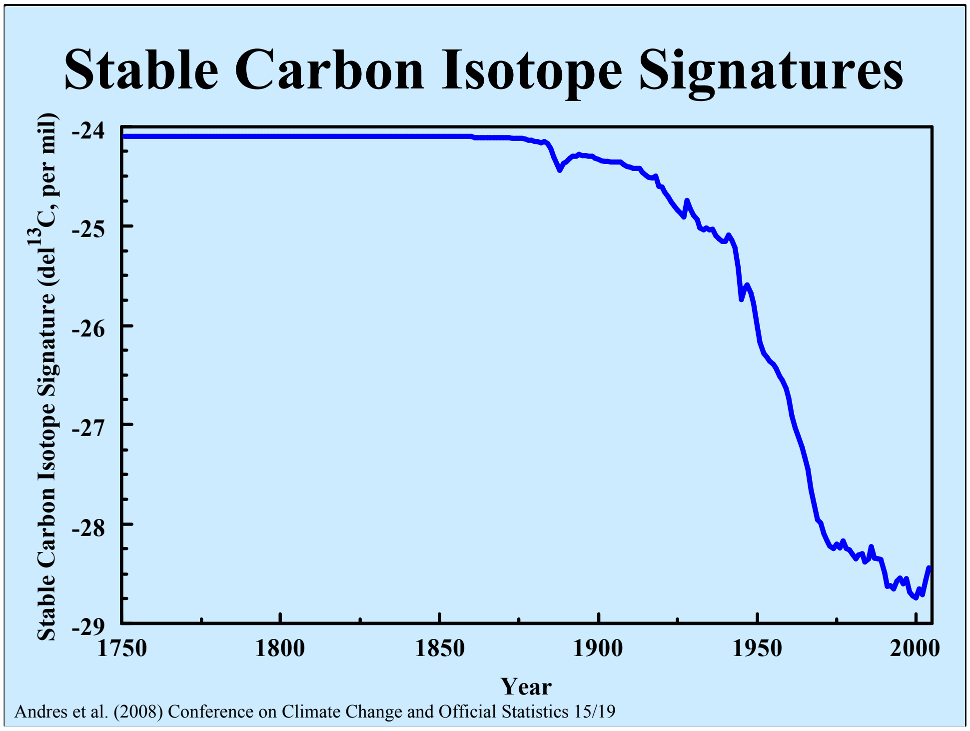
A more recent addition to our data prodcut offerings is a summation of Annex B and non Annex B countries according to the Kyoto protocol.

As you may recall, the Annex B countries have pledged to collectively reduce emissions by 5% below 1990 levels by the year 2012. They do not appear to be achieving that on a collective basis.

The non Annex B countries have no emission limits imposed on them by the Protocol. As you can see, the increasing emissions of non Annex B countries eclipse any reductions that have been achieved by the annex B countries.

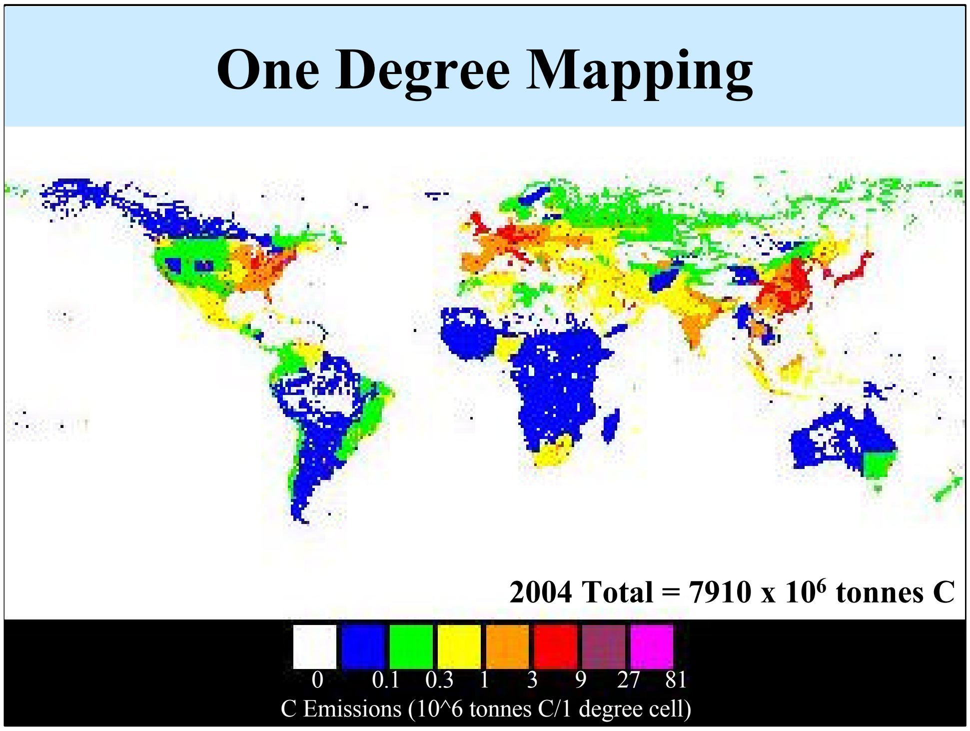


A product currently being developed and released is the pasrsing of annual emissions into monthly emissions as shown in this example for the United States of America.



Signatures are of interest because FF signatures are distinct from many other processes occurring in the C cycle. Thus, the del 13 C is a tool to distinguish different processes.

The signature is the ratio of the more common C-12 to the less common C-13 atoms in FF CO2 molecules.



Construction:

1. Tabular national CO2 emission estimates
2. 1x1 political unit map – ties tabular data to geography
3. 1x1 population map – used for within country distribution

Utility:

1. Visualizes tabular national listings in a geographical context.
2. Allows data to be easily digested into models of carbon cycle and climate.

Conclusions

1.Data being discussed here are already being used for climate change purposes.
   - whether we are ready for it or not

2. This data often does not exist in isolation, but is the result of a data gathering process.
   - we have the responsibility to produce the best data possible that our resources will allow

3. Our respective roles in this process would be enhanced through better collaboration and cooperation.
   - "best" practices have been developed and their adoption could strengthen existing efforts

Andres et al. (2008) Conference on Climate Change and Official Statistics 17/19

CDIAC is particularly interested in opportunities to collaborate with those in this room via many avenues including:

1. Comparisons of national data with similar data reported in the CDIAC carbon dioixde emissions data set.

2. Incorporation of national data of finer temporal scales (i.e., less than annual) or finer spatial scales (i.e., less than national) into existing or planned data products.

3. Incorporation of stable carbon isotope (del 13 C) data into existing or planned data products.

4. National and/or regional carbon dioixde emission studies.

5. Areas of common interest that you have identified and I have not mentioned.

Andres et al. (2008) Conference on Climate Change and Official Statistics 18/19

Please see me at the meeting or contact me after the meeting

Robert Andres

andresrj@ornl.gov

Supplementary Slides

Basic Calculation

carbon dioxide emitted = fuel consumed *
fraction of that fuel actually combusted
*** carbon content of that fuel**

Andres et al. (2008) Conference on Climate Change and Official Statistics 21/19

Tracked for 35 solid, liquid, and gaseous fuels

their relative combustion efficiencies

and their relative carbon contents

Cement

$$CaCO_3 \xrightarrow[\Delta]{} CaO + CO_2$$

Andres et al. (2008) Conference on Climate Change and Official Statistics 22/19

Cement represents approximately 3% of global total

CO2 from clinker production process only.

Fuel consumed in production process is tallied under fuel.

Apparent Consumption

apparent consumption = production + imports - exports
- changes in stocks - bunker fuels
- production of non-fuel products

Andres et al. (2008) Conference on Climate Change and Official Statistics 23/19

CO_2 emissions embodied in international trade in goods: evidence from OECD Input-Output tables

N. Yamano, OECD
Directorate for Science, Technology and Industry

UN Conference on Climate Change and Official Statistics, Oslo, Norway

14-16 April, 2008

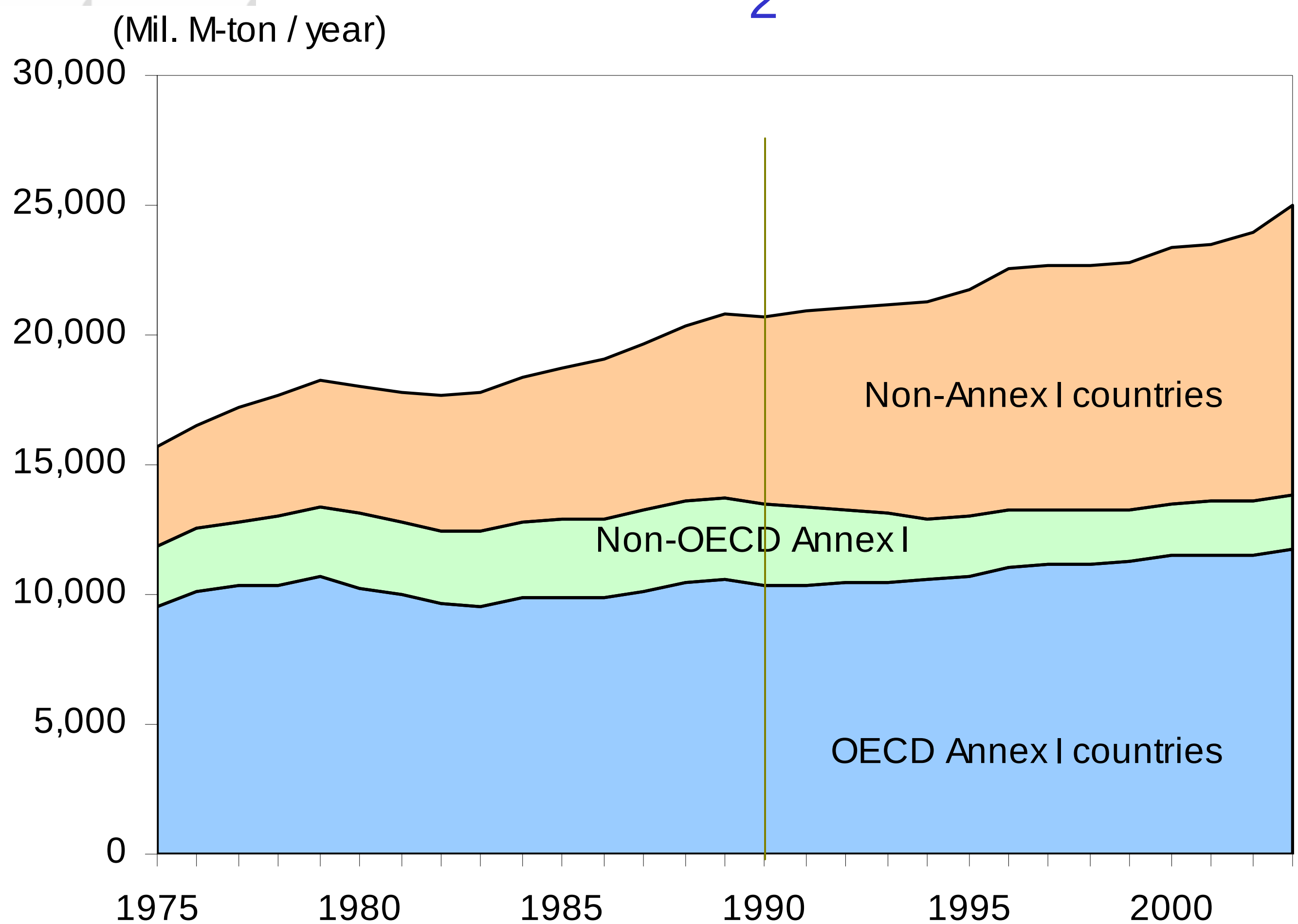
Outline

- Background
- Analytical framework
- Existing data sources
- Results
- Summary

Background

- Kyoto Protocol requires reduction in domestic greenhouse gas (GHG) emissions relative to a base year by Annex I countries.
- Encourage 'cleaner' production processes and promote transfer of technologies, using Joint Implementation & Clean Development Mechanisms.
- However, technological change has many forms: domestic emissions can be reduced by relocating production abroad, and/or by substitution of domestically produced goods with imports.
- Global emissions increase if production processes in Non-Annex I economies are more carbon-intensive than those they displace.

CO_2 emissions



Source: IEA CO_2 Emissions from Fuel Combustion

Croatia is not included for 1975-1989.

Part of Former USSR countries are estimated for 1975-1989.

1990-2003 % change

Annex I: 3.1%
Non-Annex I: 52.6%

CAN 28.6%
FRA 9.6%
DEU -11.6%
JPN 18.6%
ITA 13.3%
UK -3.6%
USA 18.3%
RUS -24.5%

OECD 4 OCDE

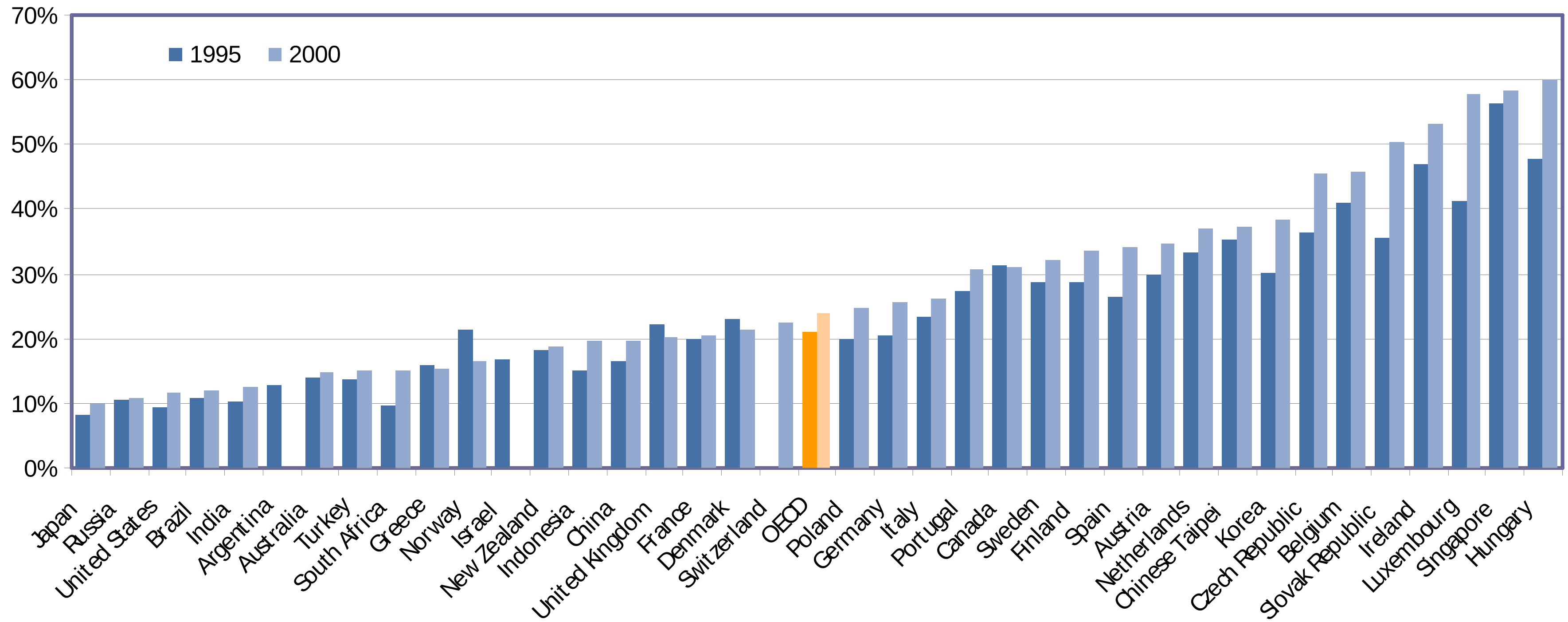
Issues related to CO_2 emissions

- Acceleration of globalisation – international outsourcing, fragmented production, global trade in goods and services etc.
- Increasing CO_2 emissions "embodied" in international trade
- Discrepancies between production based emissions and consumption based emissions
- The CO_2 balance

  = exported emissions– imported emissions

  = production based – consumption based

Import contents of exports (by country)



Source: OECD I-O 2006ed rev.1, De Backer and Yamano (2007)

-Increased in most countries
-Importance of imported goods increased.
-Larger economies have lower values

Studies of international CO_2 leakages

- Single country / Bilateral framework
  - Canada-Japan (Hayami and Nakamura , 2007)
  - China-USA (Shui and Harriss, 2005)
- Inter-country framework
  - G6 countries (Wyckoff and Roop, 1994)
  - Asian Environmental Input-Output tables
  (Hayami et al., 2000)
  - 24 countries for mid 1990s (Ahmad and Wyckoff, OECD, 2003)

OECD studies

- Ahmad and Wyckoff, 2003: combining OECD harmonised Input-Output (I-O) tables, bilateral trade tables and IEA CO_2 emissions:
  www.olis.oecd.org/olis/2003doc.nsf/linkto/dsti-doc(2003)15
  Main finding (using 'conservative assumptions'): estimates of CO_2 emissions generated to satisfy domestic demand in the OECD in 1995 were 5% higher than emissions related to production
- Follow up study (*forthcoming*):
  Yamano et al (OECD, Keio University and CRIEPI)
  - Increased country coverage: 42 countries;
  - Two data periods (rather than one)
  - 16 industries + final consumption (as before): agriculture, mining, 11 manufacturing sectors, utilities, construction, transport, other services, and final consumption;
  - Sensitivity simulations.

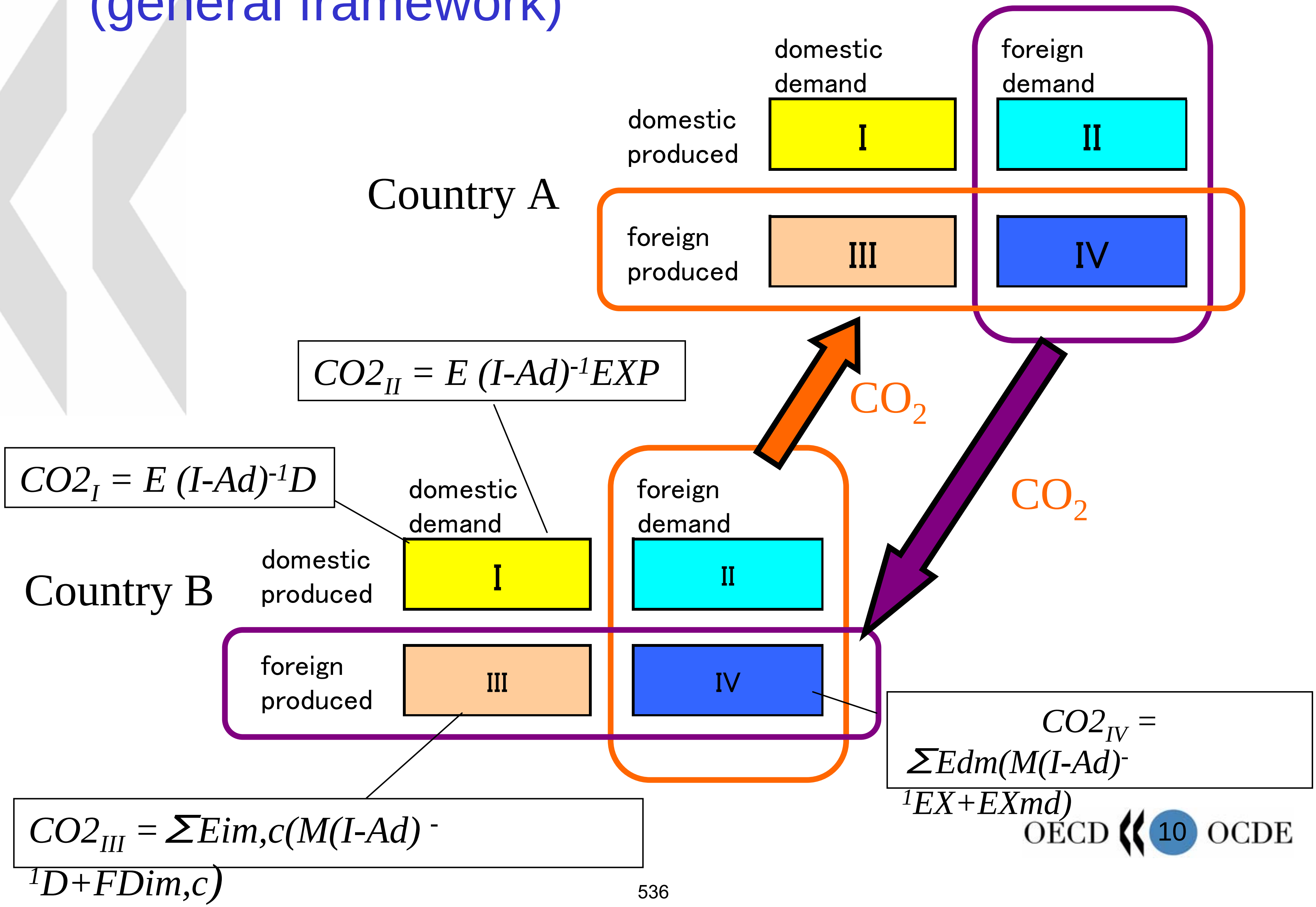
Analytical framework

- Embodied CO_2 emissions include total indirect and direct CO_2 emitted in the production of any product
- Production based and consumption based emissions are explicitly derived:
  - National I-O tables converted to USD are linked by bilateral trade
  - CO_2 emission factors (M-ton / Output) by industry are based on IEA data on CO_2 emissions from fuel combustion
  - CO_2 embodied in domestic consumption and production are calculated by I-O structure (*via Leontief inverse:* $CO2_I = E\,(I\text{-}Ad)^{-1}D$)
  - CO_2 embodied in *exports* and *imports* are eventually derived through iterative simulations.
  - The CO_2 balance

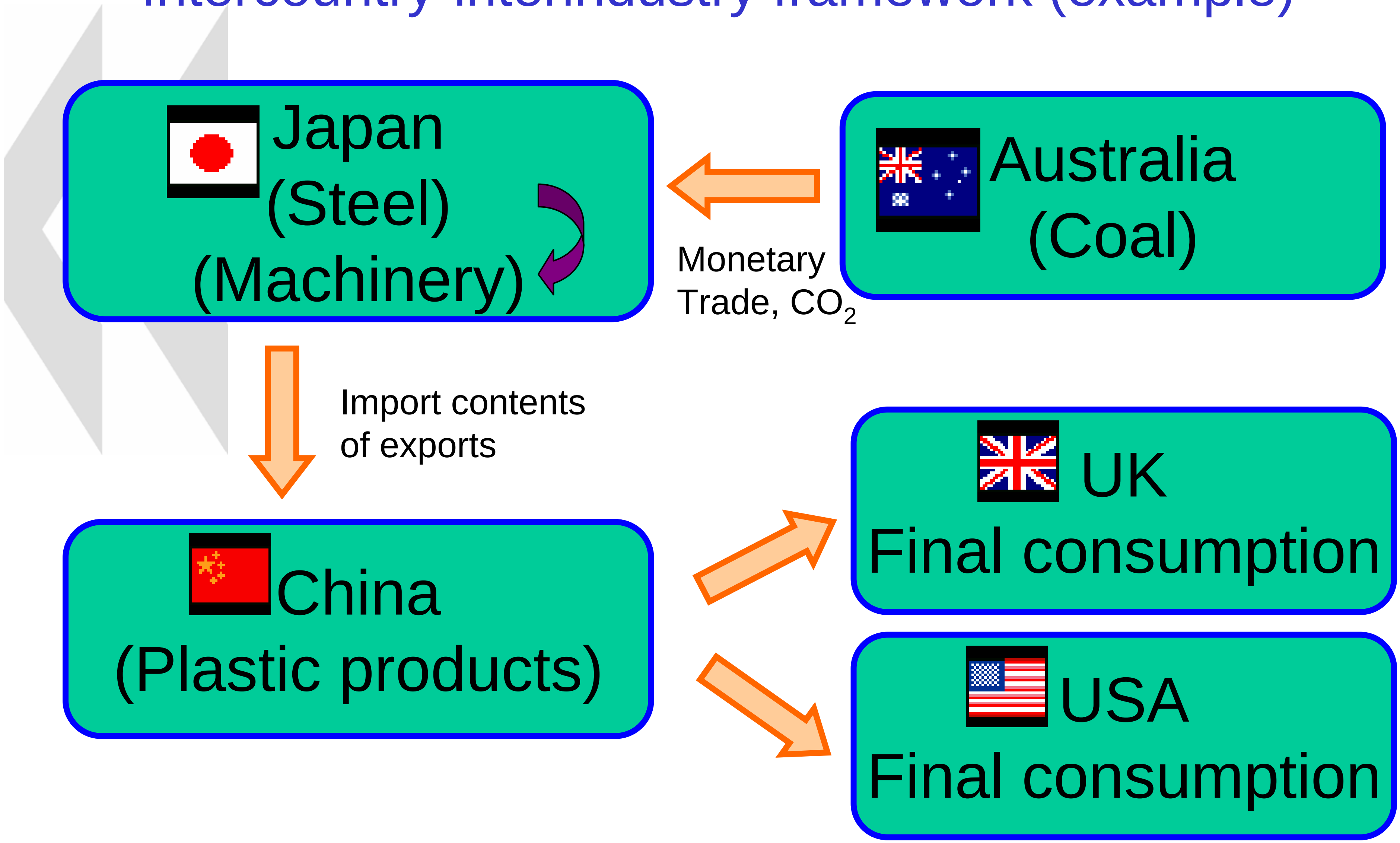
    = exported emissions– imported emissions

    = production based – consumption based

CO_2 embodied in international trade (general framework)



Intercountry-interindustry framework (example)



OECD 11 OCDE

Existing data sources

	GHG Emissions	Input-Output	Bilateral Trade in goods	Bilateral Trade in services (BoP)
Sources	IEA	NSOs	OECD,UN, Eurostat	IMF, OECD,UN, Eurostat
Sector	Aggregated sectors only	OK for most countries	Very detailed (HS 6-digit)	Not harmonised with Industry classification
Year	Good	Recent years not available	Good	Only recent years
Country coverage	Good	Good	Good	Poor
International comparability	Good	Various formats	Mirror statistics problems (re-exports)	Mirror statistics problems

OECD 12 OCDE

OECD data coverage

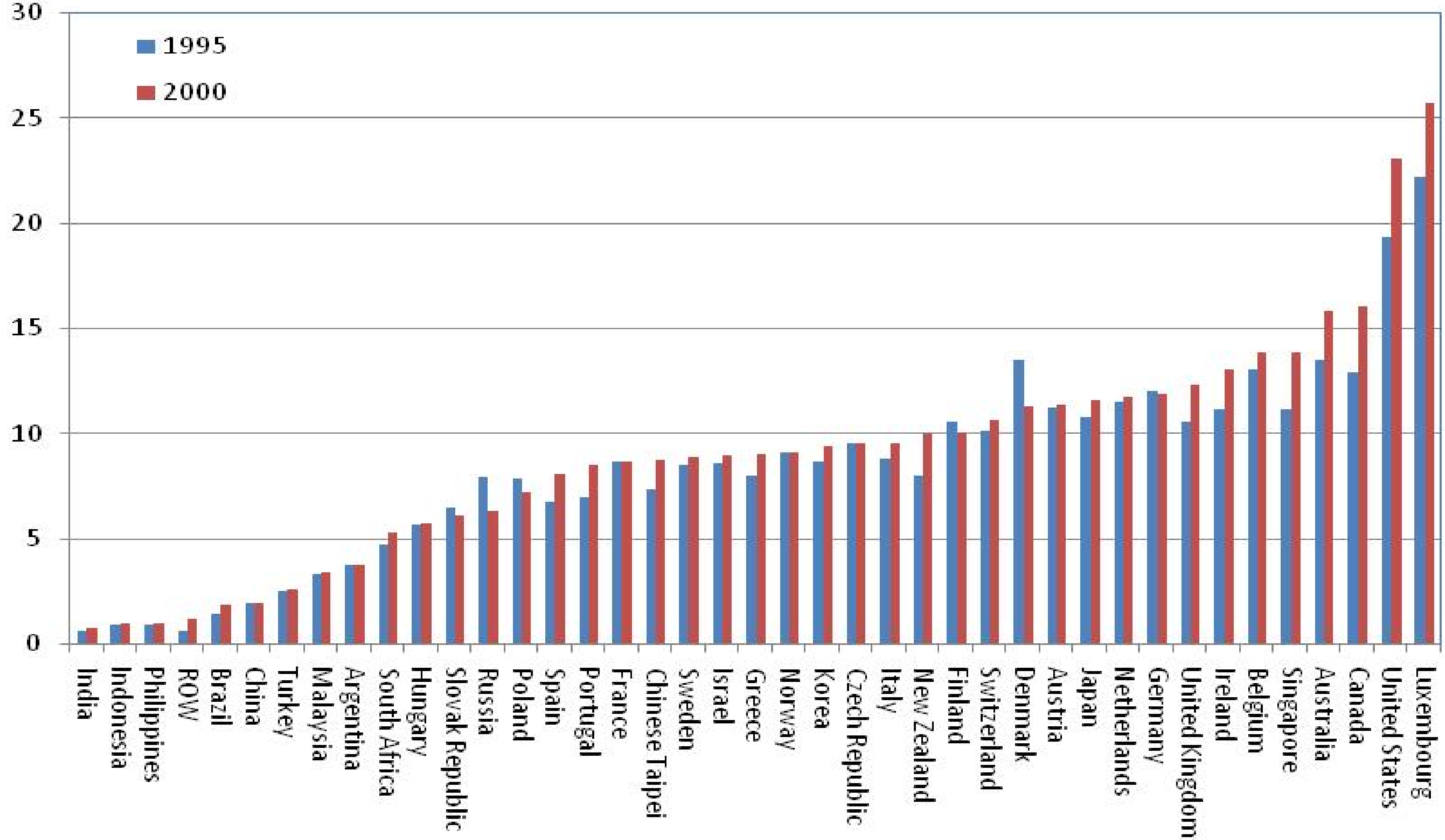
- Input-Output
  - Harmonised classification (48 activities based on ISIC Rev.3) and common price valuation
  - 38 countries(95%+ of global GDP and 70%+ of world population) from *OECD I-O 2006ed Rev.1*
  - Other sources
- Bilateral trade of goods
  - OECD STAN BTD (HS product data converted to ISIC Rev.3 classification - *goods producing industries*) supplemented by OECD ITCS, UN Comtrade
- CO_2 emissions from fuel combustion (IEA)
  - 16 industries (limits coverage of embodied CO_2 analyses)

OECD 13 OCDE

Exogenous and endogenous variables

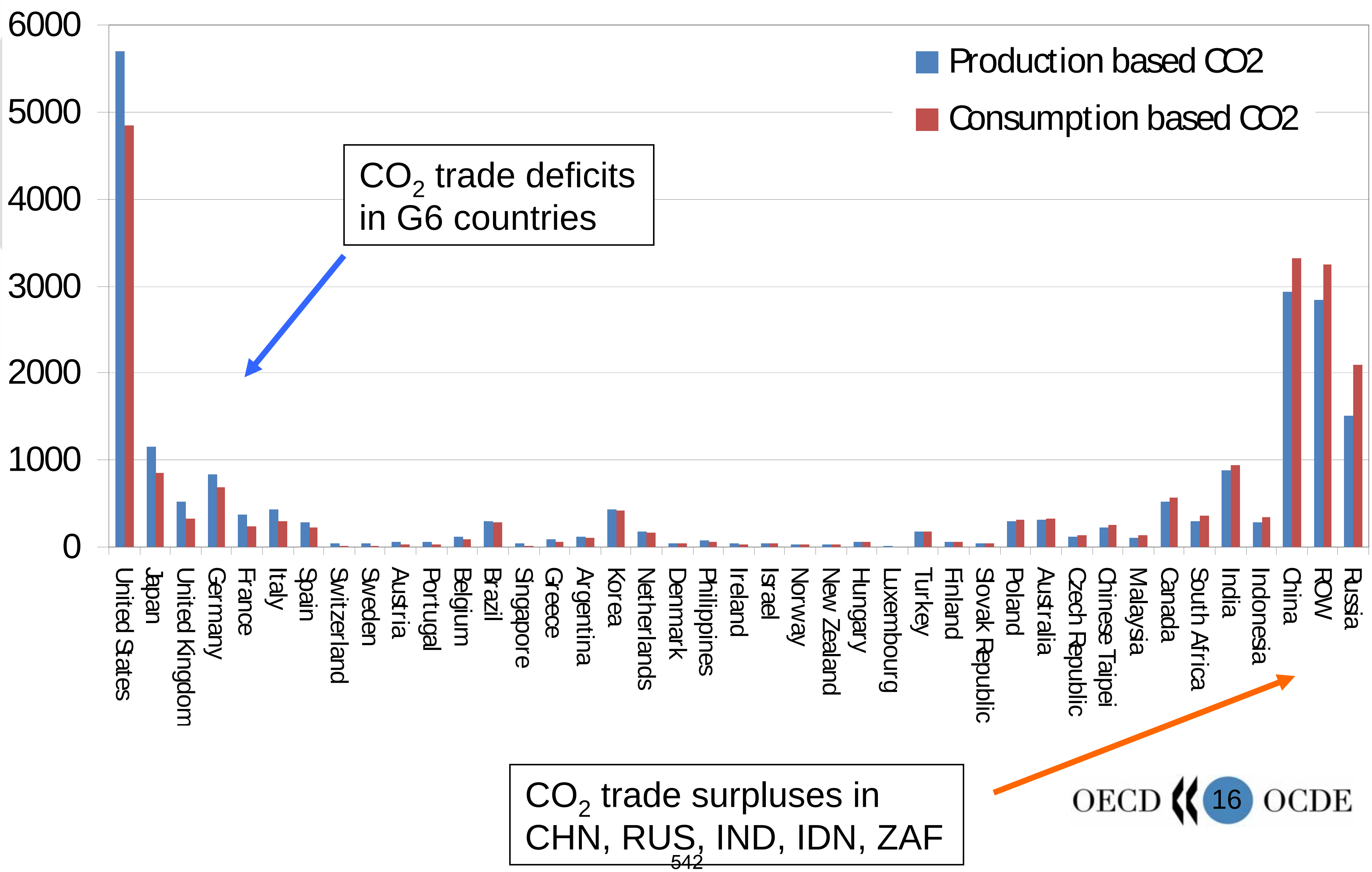
- Exogenously given
  - CO_2 emission factors by industry
  - Ratio of imported to domestic sources
  - International trade pattern (procurement patterns) by industry
  - Final demand in each country is fixed
- Endogenously determined
  - CO_2 embodied in imports and exports
  - Economic variables (output, import, etc)

Consumption based emissions per capita mid-90s and early-00s

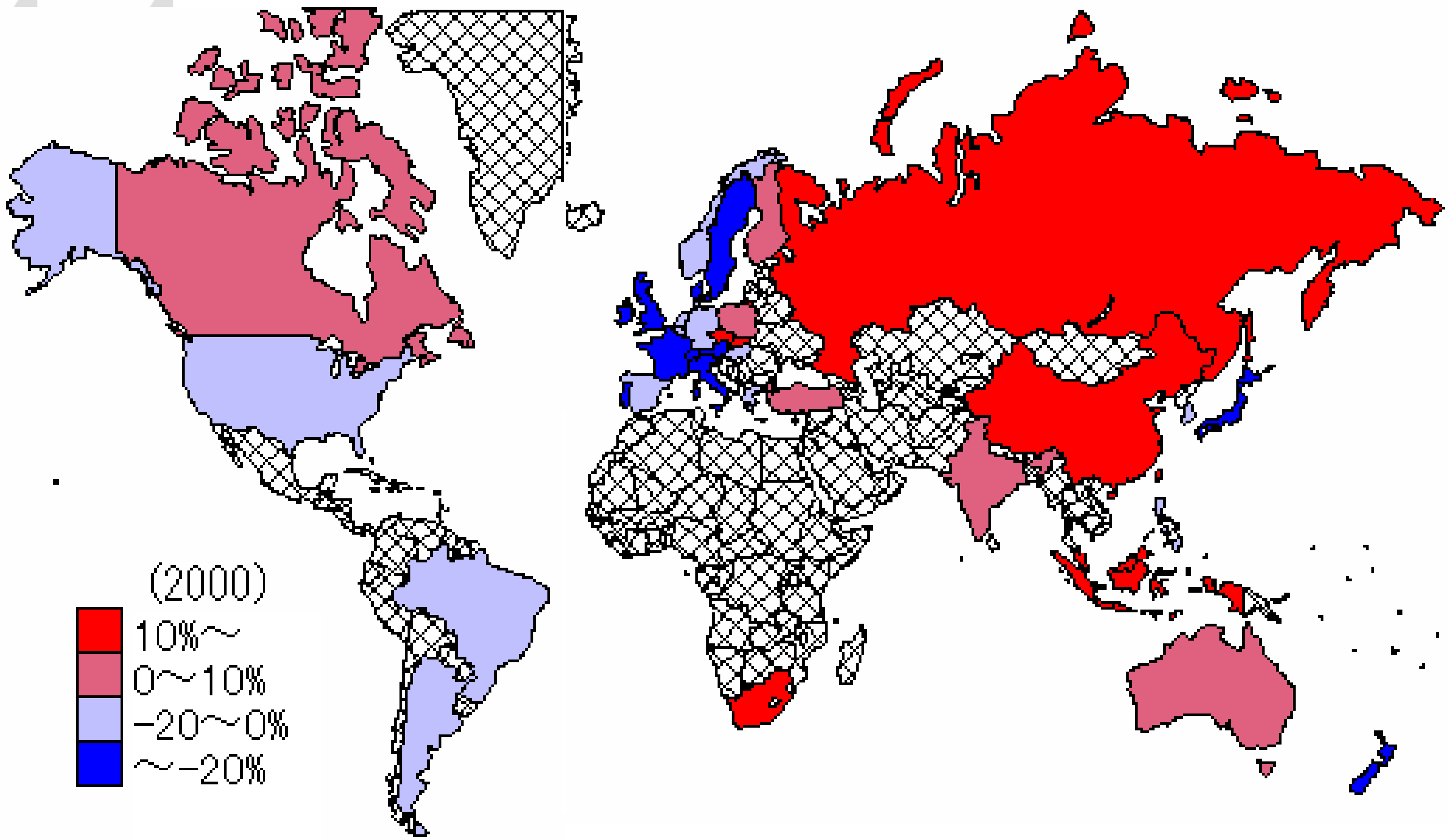


OECD 15 OCDE

Consumption and production based CO_2 emissions (early 2000s)



CO_2 trade balance as % of production-based emission



The trade deficit in CO_2 embodied in trade has increased in most OECD countries as consumption has increased.

Measurement results

- In the late 1990s, the consumption based emissions increased in 20 OECD countries
- Two-thirds of world increases in emissions originated in non-OECD economies
- Half of the global increase is due to OECD consumption
- In the early 2000s, the G6 economies (G7- Canada) were net importers of CO_2.
- Five major non-OECD countries (Russia, China, India, Indonesia, South Africa) account for 80% of CO_2 trade surplus.

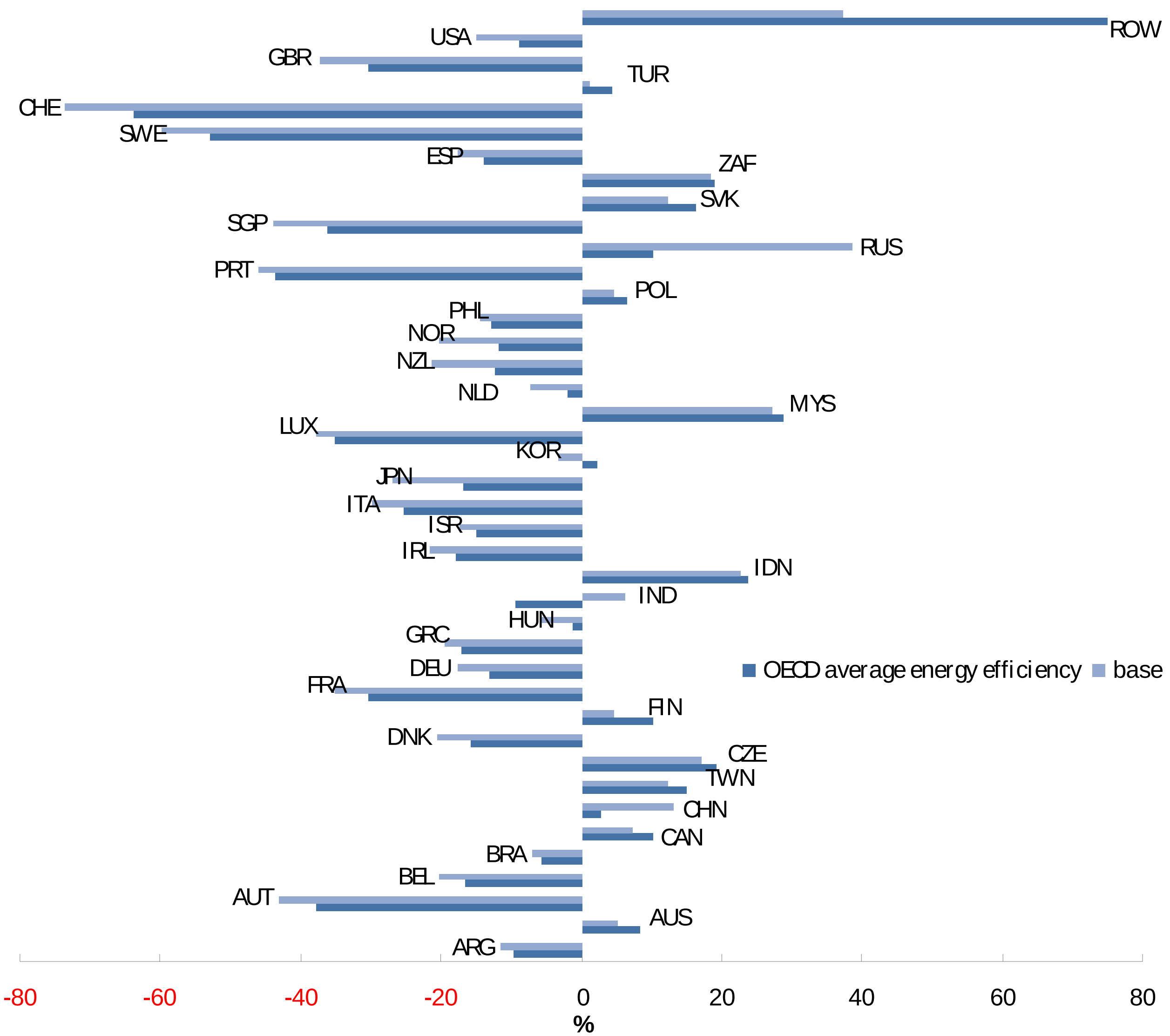
Simulation examples

1. Base case for the mid 1990s and the early 2000s
2. Increase in import coefficients
   - The sensitivity analysis on changes in import coefficients is available for the globalisation effects
3. Increase in energy efficiency
   - Increased energy efficiency in non-member country reduces the global emissions and CO_2 trade

1. Increase in import coefficients

OECD 20 OCDE

2. Increase in energy efficiency



21

Are NSO statistics adequate?

Data wish list

- Input-Output
  - More timely Supply-Use / I-O tables
  - More industry detail for some countries
  - Common price valuation
  - Investment flows
- Bilateral trade (goods)
  - Improved information to address mirror statistics problems and better capture trade from recent production:
    - Data on re-exports (a significant % of exports for some countries)
    - Composition of ‘un-allocated’ trade (i.e. HS 99 .. n.e.c.)
    - Better identification of trade in scrap, waste and second-hand goods
    - Identification of exports from recycling industry
- Bilateral trade (services)
  - Improved country and time series coverage
  - Links to industry classification
- CO_2 (and other GHG) emissions - more industry detail
- Improved measures of transport emissions
- Industry specific conversion rates (PPPs)

Subject of OECD project to adjust trade data for linking I-O tables

OECD 22 OCDE

Summary

- Despite limitations of the underlying data, this methodology provides an important diagnostic tool for understanding dynamics of worldwide CO_2 emissions
- The methodology can be applied to other international embodied analyses e.g. other GHG, virtual water, ecological footprint, technology spillovers (embodied R&D / innovation / skills) etc.
- Analyses would benefit significantly from improved data sources

Thank you

norihiko.yamano@oecd.org

For further reading

- Basic overview of use of I-O tables - http://www.oecd.org/dataoecd/6/34/37349386.pdf
- Description of latest version of OECD I-O database - http://www.oecd.org/dataoecd/46/54/37585924.pdf
- Measuring globalisation with I-O tables - http://www.oecd.org/dataoecd/41/18/39936529.pdf
- Embodied CO_2 - http://www.olis.oecd.org/olis/2003doc.nsf/linkto/dsti-doc(2003)15
- Datasources
  - www.oecd.org/sti/btd
  - www.oecd.org/sti/inputoutput

CONFERENCE ON CLIMATE CHANGE AND OFFICIAL STATISTICS

Oslo, Norway14 – 16 April 2008

Experiences on GHG Inventory and Climate Change Activities

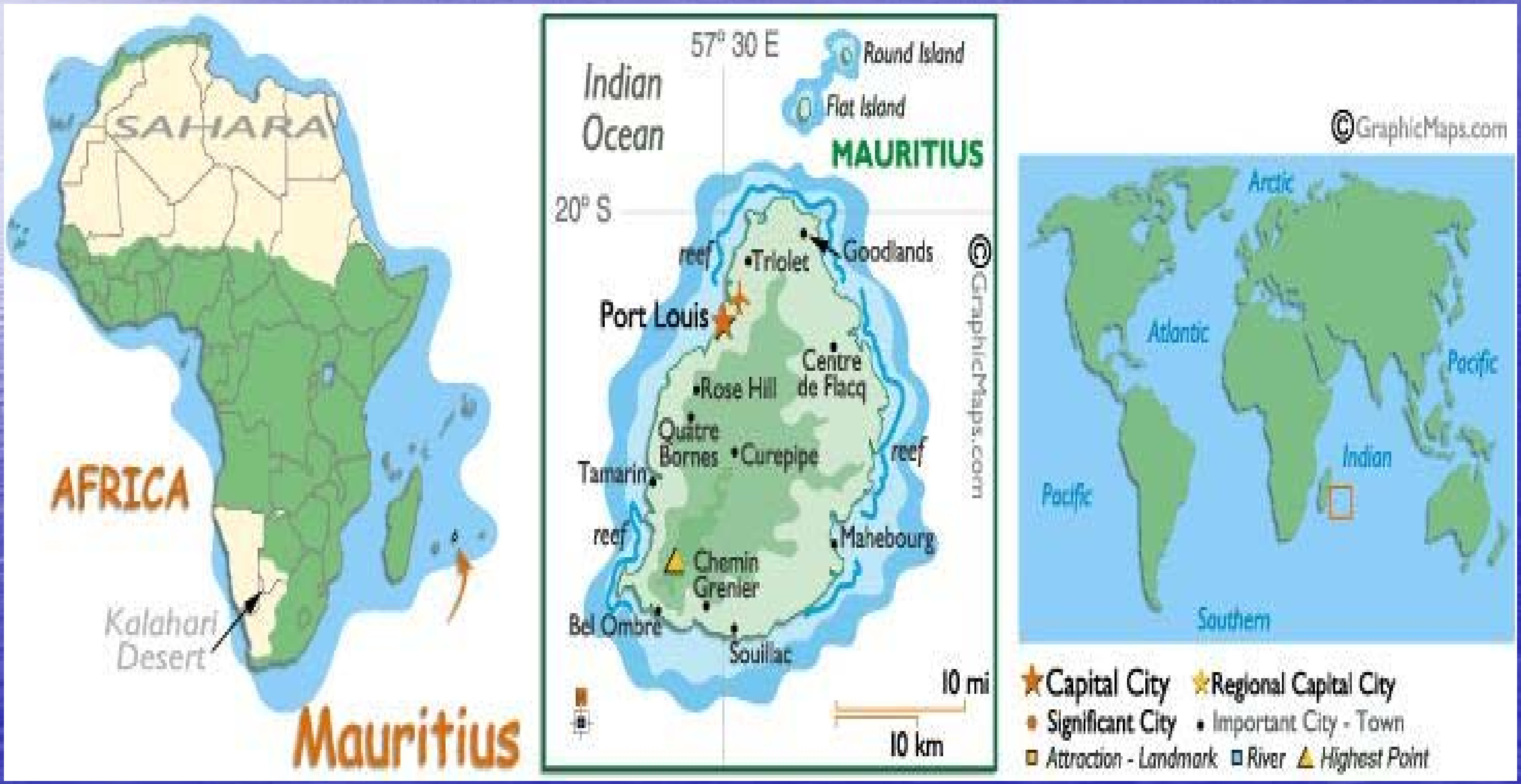
By

Participants from Mauritius

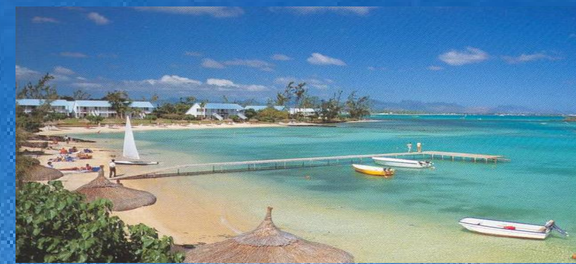
Mr. Santaram Mooloo *(Ministry of Environment and National Development Unit)*
and Mr. Anand Sookun *(Central Statistics Office-Environment and Energy Units)*

LOCATION

- Africa – Indian Ocean



Country Snapshot



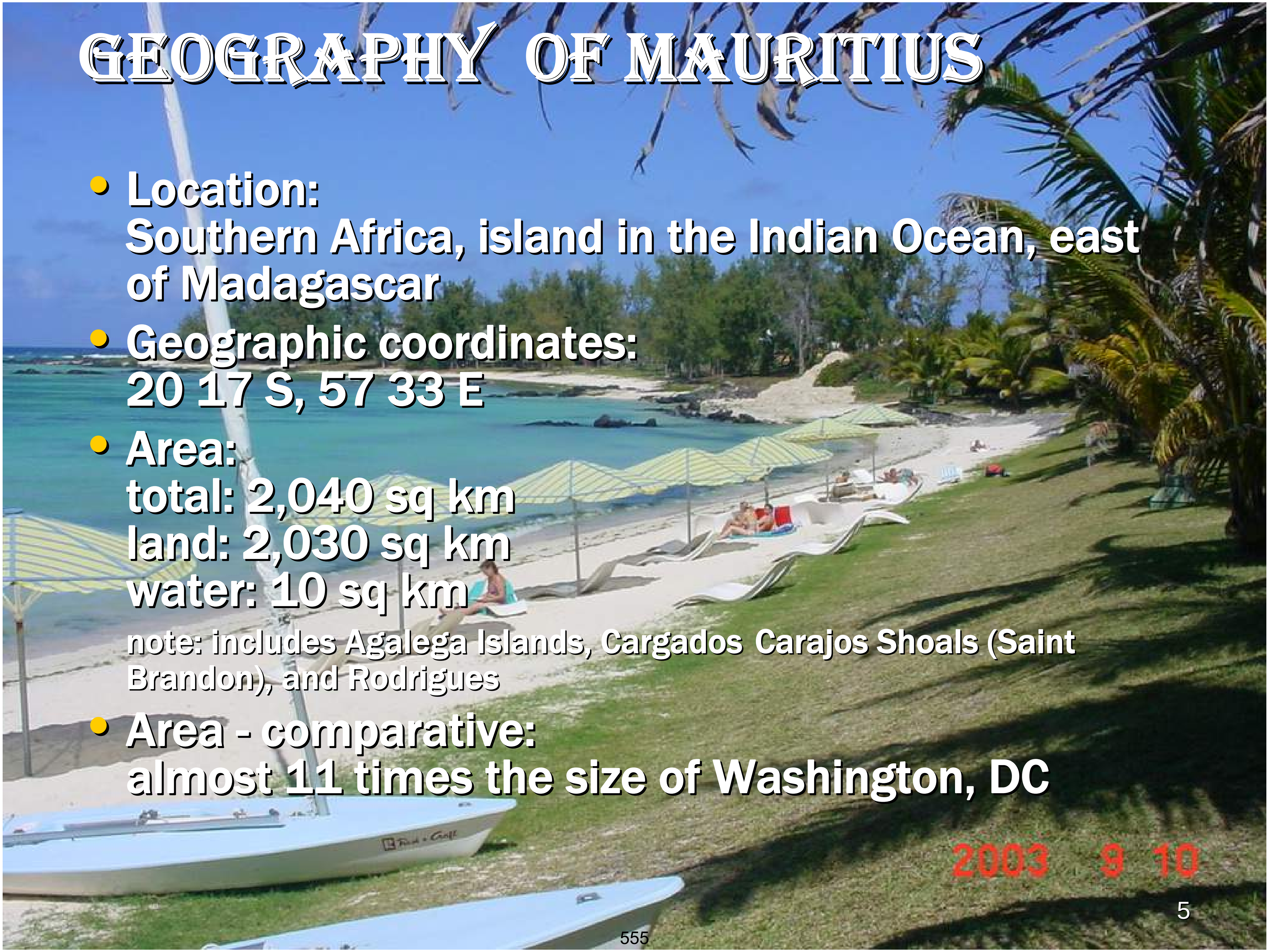
- Although known to Arab and Malay sailors as early as the 10th century, Mauritius was first explored by the Portuguese in 1505;

- It was subsequently held by the Dutch, French, and British before independence was attained in 1968.

- A stable democracy with regular free elections and a positive human rights record, the country has attracted considerable foreign investment and has earned one of Africa's highest per capita incomes.

Facts and Figures

- Official Name: Mauritius
- Capital City : Port Louis
- Languages: English (official), French, Hindi, others
- Official Currency : Mauritian Rupee (MRU: US $ =27:30)
- Religions: Hindu, Christian, Muslim, others
- Population: 1,250,882 (July 2007 est.)
  Land Area (Mainland) : 1,860 sq km (718 sq miles)



GEOGRAPHY OF MAURITIUS

- **Location:**
  Southern Africa, island in the Indian Ocean, east of Madagascar
- **Geographic coordinates:**
  20 17 S, 57 33 E
- **Area:**
  total: 2,040 sq km
  land: 2,030 sq km
  water: 10 sq km
  note: includes Agalega Islands, Cargados Carajos Shoals (Saint Brandon), and Rodrigues
- **Area - comparative:**
  almost 11 times the size of Washington, DC

ECONOMIC INDICATORS

- **GDP (purchasing power parity):** $14.9 billion (2007 est.)
- **GDP - per capita (PPP):** $11,900 (2007 est.)
- **GDP - composition by sector:**
  agriculture: 4.8%
  industry: 25%
  services: 70.1% (2007 est.)

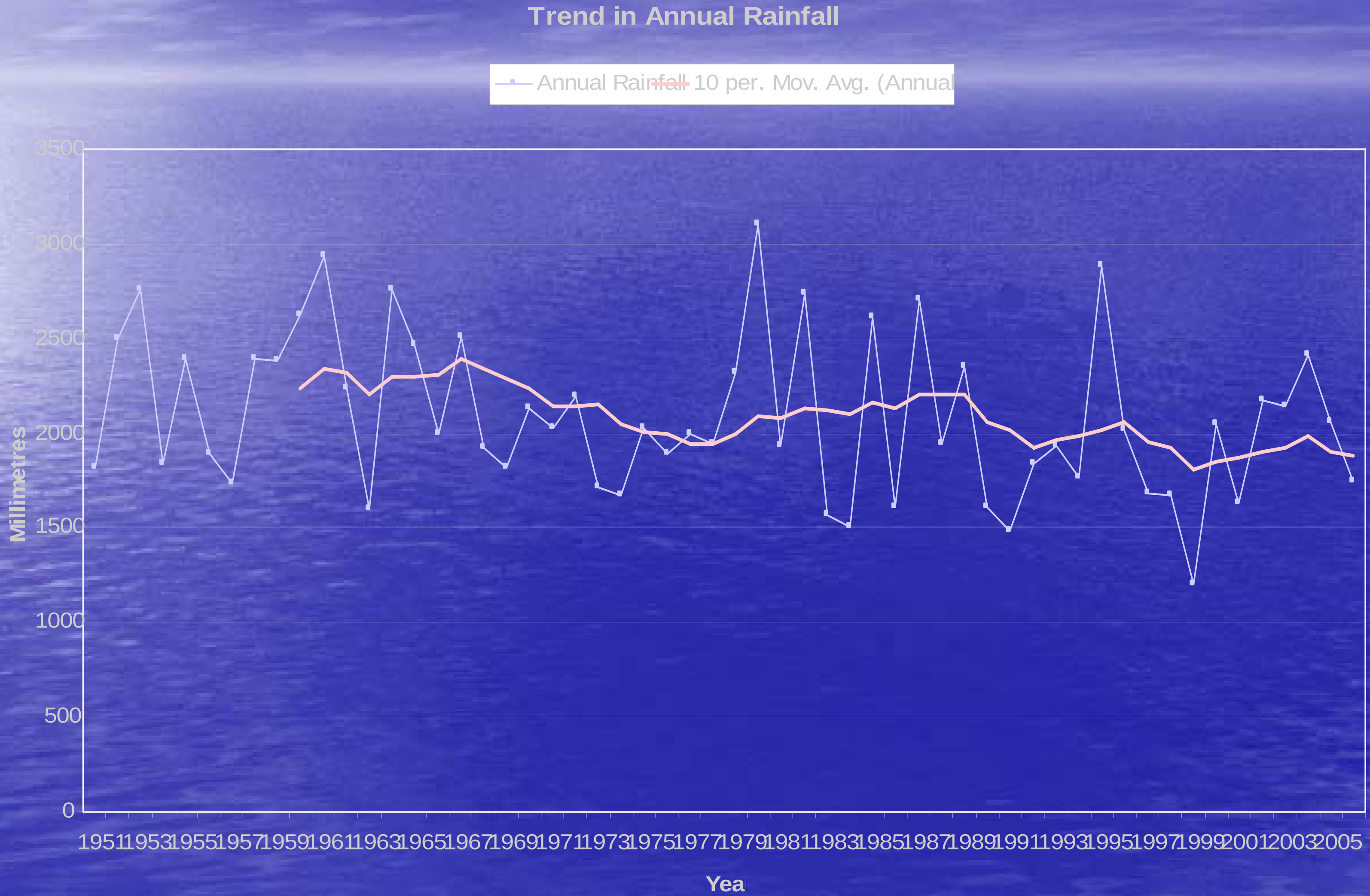
CLIMATE

- Climate:
  tropical, modified by southeast trade winds; warm, dry winter (May to November); hot, wet, humid summer (November to May)
- Terrain:
  small coastal plain rising to discontinuous mountains encircling central plateau
- Elevation extremes:
  lowest point: Indian Ocean 0 m
  highest point: Mont Piton 828 m
- Natural resources:
  arable land, fish
- Land use:
  arable land: 49.02%
  permanent crops: 2.94%
  other: 48.04% (2005)
- Irrigated land:
  220 sq km (2003)

Effects of Climate Change in Mauritius

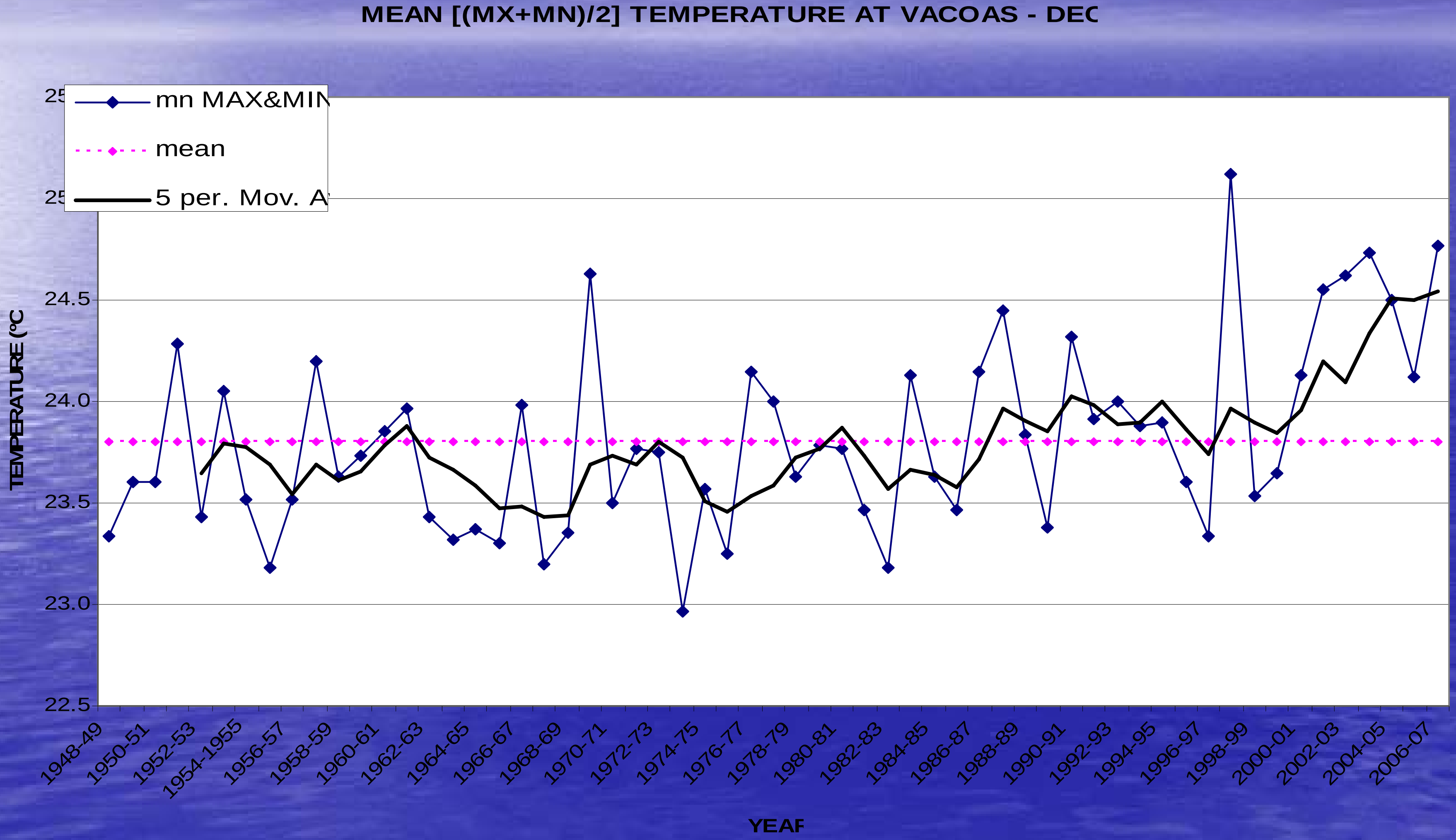
- **Year 2006 was 0.74 degrees Celsius warmer than normal**
- **Average Temperature during the last decade (1997-2006) was higher than the normal by 0.60 to 1.0 degrees Celsius**
- **Year 2006 was the third warmest year after 2003 and 1998**
- **Mean temperature (1997-2006) has risen by 0.86 degrees Celsius compared to decade 1961-70**
- **Seven of the warmest years ever (1998, 2001, 2002, 2003, 2004, 2005, 2006) occurred in the last decades**
- **Mean Sea Level Rise during the past decade (1997 – 2006) = 1.2 cm**
- **Mean Sea Level Rise per year = 1.2 mm**

Precipitation Trend - Mauritius



9

Temperature trend - Mauritius



ENVIRONMENT

- **Natural hazards:**
  cyclones (November to April); almost completely surrounded by reefs that may pose maritime hazards
- **Environment - current issues:**
  water , energy, coastal zones
- **Environment - international agreements:**
  party to: Antarctic-Marine Living Resources, Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, Wetlands signed, but not ratified: none of the selected agreements

MITIGATION AND ADAPTATION In Mauritius

- Mauritius being a non-Annex 1 country has NO obligations to reduce green house gases but as signatory of the UNFCCC, mitigation and adaptation measures in line with the objectives of the UNFCCC objectives are being taken
- Coastal protection works, mangrove propagation programme, monitoring and protection of coral reefs
- *Renewable Energy:* use of solar water heaters Energy Efficiency and Energy Conservation in Buildings
- From use of petrol to liquefied petroleum gas
- Production of energy through renewable sources

12

National communications

- National Communications- a reporting tool at the international level of monitoring of national GHG emissions
- Commitments of Parties to UNFCCC
- Initial National Communication submitted in 1999
- Second National Communication now due

ACTION INITIATED UNDER THE UNFCCC in Mauritius.

- A multi-sectoral National Climate Committee (NCC) was established in June 1991 under the chairmanship of the Prime Minister's Office and co-chaired by the Meteorological Services.

- A National Climate Change Action Plan has been prepared by the National Climate Committee in 1998.

- The Ministry of Environment & NDU has set up an Implementation Committee in 2001 to coordinate the implementation of this Action Plan.

- Mauritius submitted its Initial National Communication (national inventory of sources and sinks of greenhouse gases) to the UNFCCC secretariat in 1999, and is in the process of submitting its Second National Communication

Successful implementation of the SNC will:

- Facilitate integration of climate change responses into national development priorities (agri.,health, infras...)
- Provide substantive inputs to policy-makers to address climate change concerns (budgetary allocations)
- Further enhance public awareness of climate change
- Generate knowledge and disseminate information on climate change at different levels of the society

SNC Project groups

- 6 Team Leaders for the different working groups:

- GHG Inventory
- National Circumstances
- Vulnerability and Adaptation (V&A)
- Mitigation
- Projects and Policies
- Education. Training and Public Awareness

What is a National GHG Inventory?

- A framework which provides all the emissions by source and removals by sink, of GHG's (whenever and whatever applicable), based on the IPCC Guidelines

- Important because most man-made impacts on the climate derive from consumption and production activities that releases GHG's

- The main GHG is CO2. Other's: CO. CH4, NO_2,N_2O,NMVOC and SO_2

INVENTORY

- First Inventory for Mauritius was attempted at during the Climate Change Action Plan in the early 90's
- During the preparation of the Initial National Communications (INC), the complete inventory for 1995 was compiled
- As from 2000 subsequent inventories were compiled using the1995 template and methodologies (Tier 1)
- The 1996 Revised IPCC Guidelines were used

Greenhouse Gas (GHG) Inventory

Inventory Agency Responsibilities

- A single national entity is responsible for the overall inventory – The CSO
- Arrangements with collaborating entities that contribute data, research, estimate emissions or provide expert reviews
- Define legal authority to collect and disseminate data necessary for the preparation of the inventory
- Ensure inventory processes are in compliance with COP decisions
- Define and apply procedures for collecting data, preparing inventory, communicating results, submitting report, and archiving
- Liaise among government departments, national agencies,
- Ensure the implementation of QA/QC

Institutional Set up

- Mauritius Meteorological Services
  - Ministry of Environment
  - Central Statistics Office
  - Other Stakeholders

Team Set Up

- Orginisation

Coordination Environment and Energy Statistics Unit

Sectoral Team Leader
ENERGY
CEB
CSO
MPU
UOM

Sectoral Team Leader
TRANSPORT
NTA
CSO
MPI

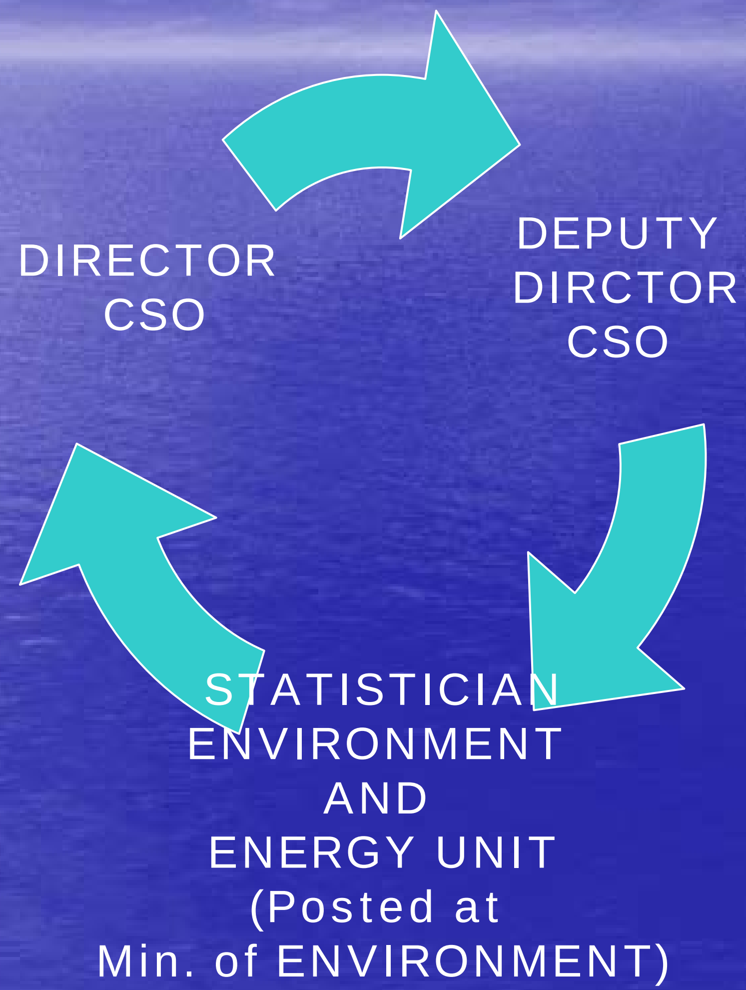
Sectoral Team Leader
INDUSTRIAL PROCESSES
MI
CSO
ENV

Sectoral Team Leader
AGRICULTURE
AREU
MSIRI
AGRO

Sectoral Team Leader
LAND USE, LAND USE CHANGE AND FORESTRY
UOM
FOREST
MHL

Sectoral Team Leader
WASTES
MLG
ENV

Organisational Set up at CSO



PROPOSED NATIONAL STRATEGY FOR THE DEVELOPMENT OF STATISTICS (NSDS)

- Reform the National Statistical System (NSS)
- Provide better statistics
- Better policies
- Better Development outcomes

Linkages for GHG Inventory

Research & national scientific community – E.g.Univ. of Mauritius

Central Statistics Office

Forestry Department
LU/LUCF
(SINKS POLICIES)

Inventory Program

Mauritius Meteorological Services

Min. of Environment

Interest groups & the public

Emission projections, climate & economic modeling

Tasks for the GHG Team

- Participate in workshops and meetings
- Collect all the Activity Data (AD) required
- Use appropriate methods to develop or estimate Emission Factors (EF)
- Review and fill data gaps
- Compile the emissions
- Perform QA/QC on all data
- Document all methodologies
- Archive all data and information

METHODOLOGIES

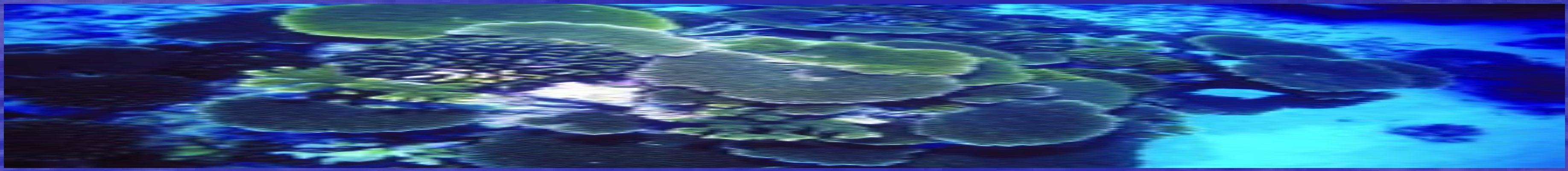
- **Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories**
- Parties should only use the **latest version** (i.e. **Revised 1996**) of the "IPCC Guidelines for National Greenhouse Gas Inventories" (3 volumes)
- The use of IPCC Guidelines is enhanced by the **inventory software**.
- These Guidelines are **complemented** by the IPCC **GPG**.
  - The **GPG on Uncertainty** - 2000
  - The **GPG on LULUCF** – 2003
  - 2006 Guidelines

Tiers 1 and 2 or 3 methodologies

- The **higher** the number designating the tier, the **more detailed** is the methodology and the **more accurate** are the emission estimates.

- **Tier 1** represents the **minimum**, or default, methodology. If sufficient data is available, a Party can also try to apply a higher tier.

- **Tiers 2 or 3** involve **more elaborate methods** which could be either source category-specific or technology-based. These methods require more detailed data and/or measurements for their application.



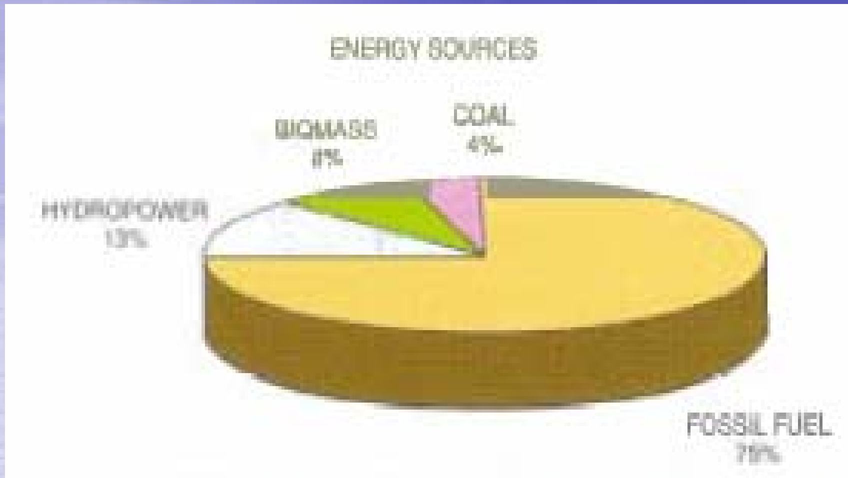
SECTORS AND DATA SOURCES

- Energy: Energy Balance and Trade - CSO
- Agriculture: Agric Stats – CSO & Agric. Ministry
- Land Use, Land Use Change and Forestry (LULUCF): Forestry Services
- Industrial Processes: Industries
- Waste: Environment Stats – CSO & Min. Local Govt.

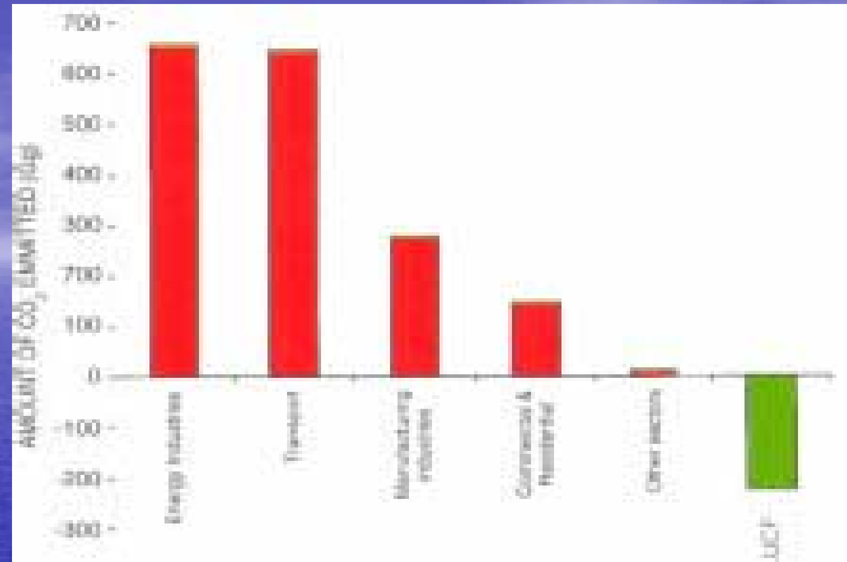
Output

- **The Second National Communication which is a document to be submitted as part of our obligation under the UNFCCC is presently under preparation. Apart from providing an inventory for greenhouse gas emission, it will also identify Mitigation and Adaptation measures which will be submitted to funding agencies including the GEF and the Adaptation Fund**

Emissions 1995

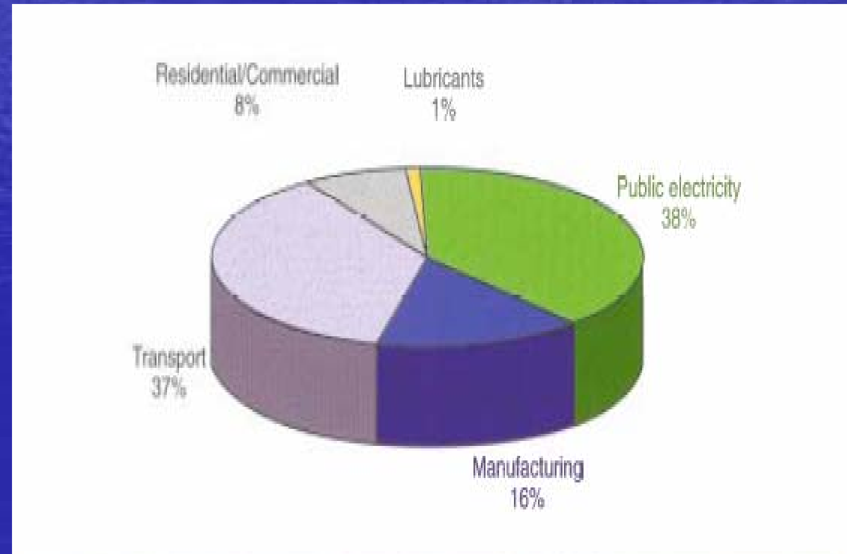


Energy sources



GAS	AMOUNT (Gg)
CH_4	4.600
N_2O	0.727
NO_X	10.180
CO	67.003
NMVOC	15.481
SO_2	13.369

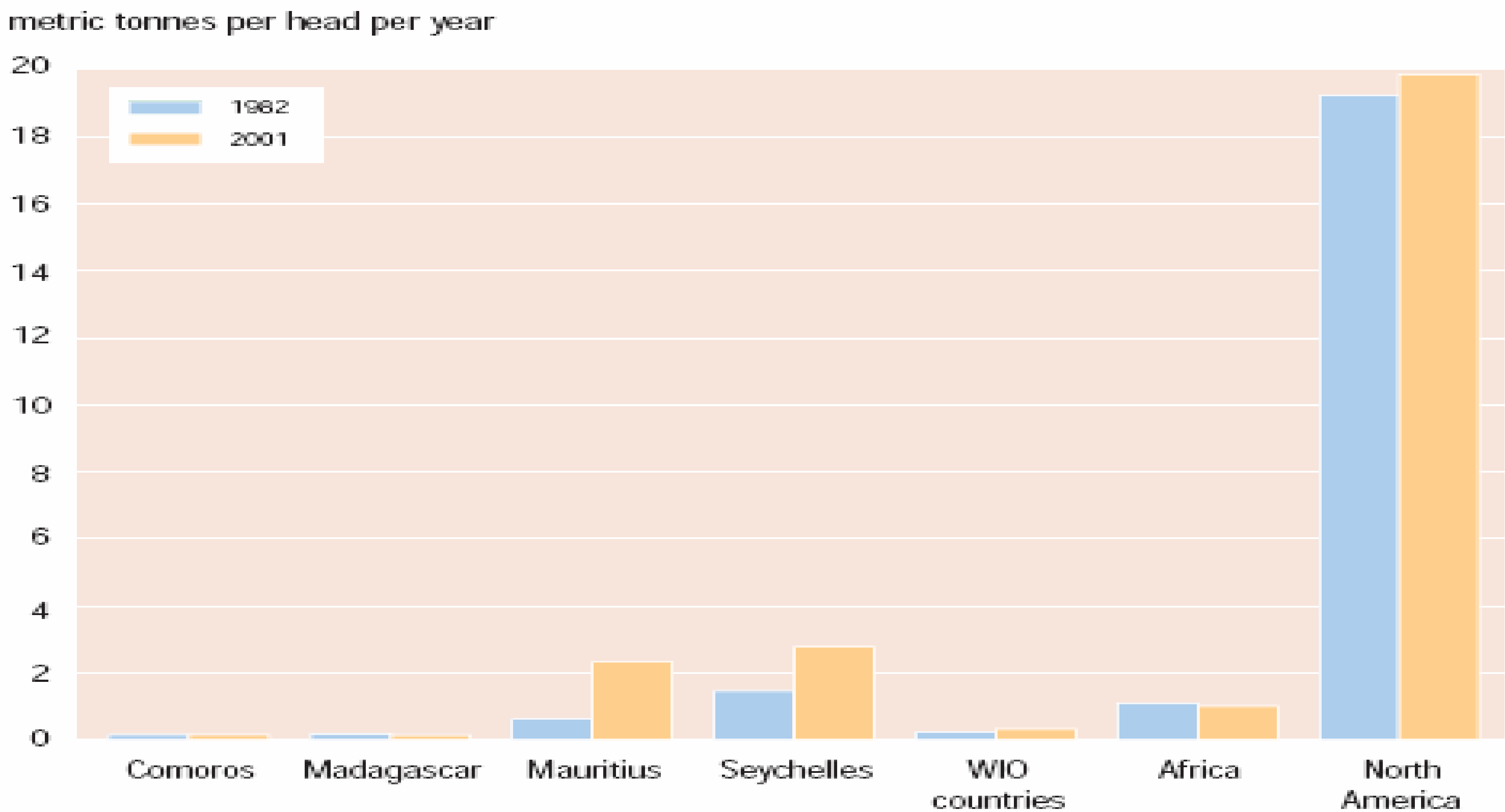
Non-CO_2 emissions



Sectoral CO_2 emissions from fossil fuel

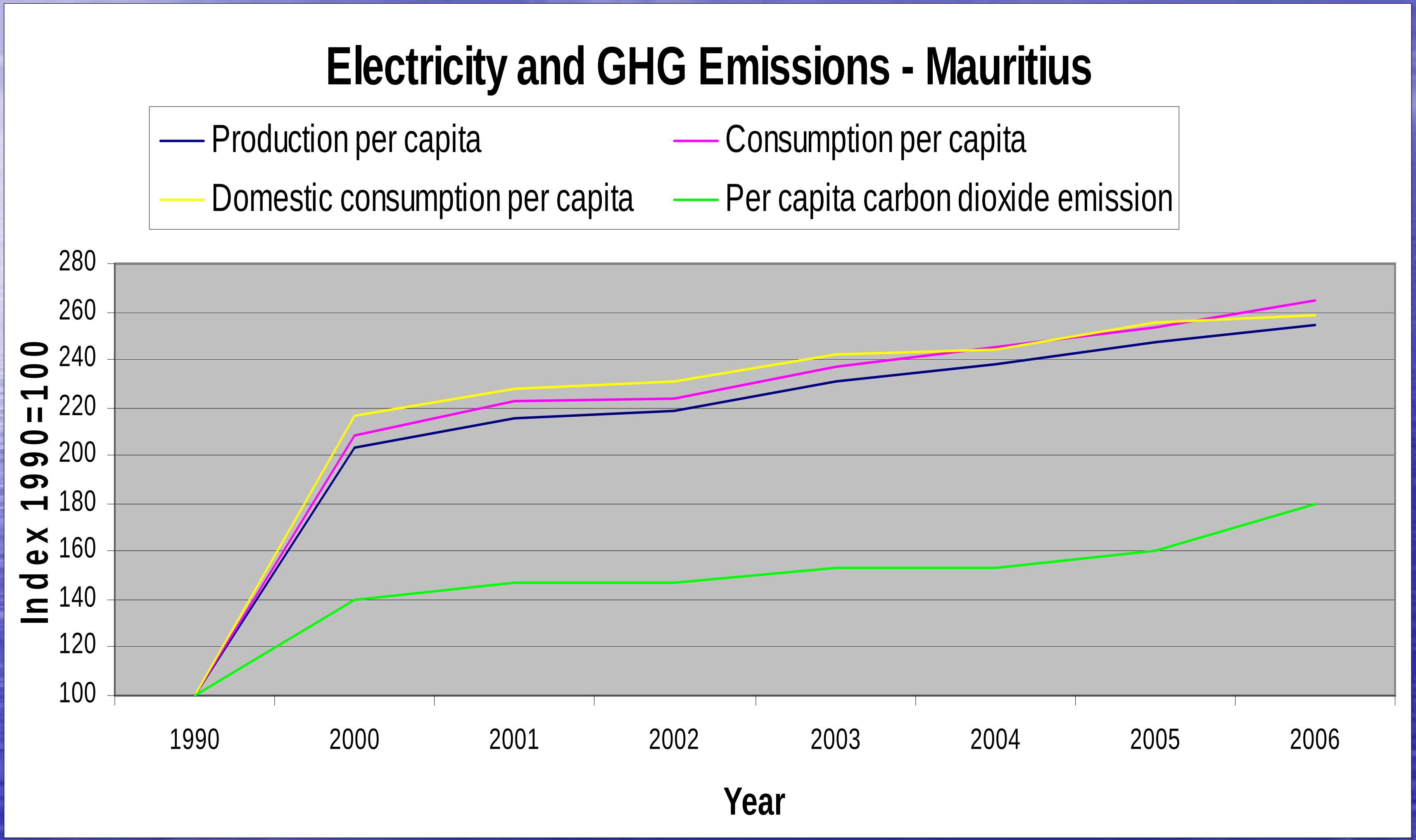
CO_2 Emissions per capita

Figure 9: Comparison of emission levels



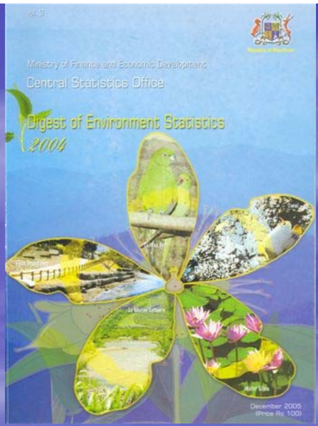
Source: UNEP 2005b

Trends



Electricity and GHG Emissions - Mauritius
Production per capita
Consumption per capita
Domestic consumption per capita
Per capita carbon dioxide emission
Index 1990=100
280
260
240
220
200
180
160
140
120
100
1990
2000
2001
2002
2003
2004
2005
2006
Year

Uses of GHG emissions data



- International commitments – UNFCCC, UNDP, COI, SADC, MDG's,Africa Environment Information Network (AEIN), etc
- Local : Environment Statistics, Environment Accounting, Environment Information System (EIS),
- Building baseline for Carbon Credits, CER's, CDM's etc
- Scenario Building

Final Remark

*A national inventory is **not** a research project…*

*It is a **national program** that works closely with statistical and research institutions to create high quality emissions data.*

Michael Gillenwater – GHG Management Institute, USA

That's all

THANK YOU

ON THE PROBLEMS OF STATISTICAL DATA PROVISION FOR GREENHOUSE GAS EMISSIONS CALCULATIONS

K.E. Laykam, Doctor of Economy, Deputy Head,
Federal State Statistics Service (*Rosstat*)

14 April 2008, Oslo, Norway

Kyoto Protocol to the United Nations Framework Convention on Climate Change (December 11, 1997)

⇓

The Federal Law of the Russian Federation "On the Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change"
№ 128-ФЗ of November 4, 2004

⇓

The Decree of the Government of the Russian Federation (№ 275-р, of February 20, 2006)

⇓

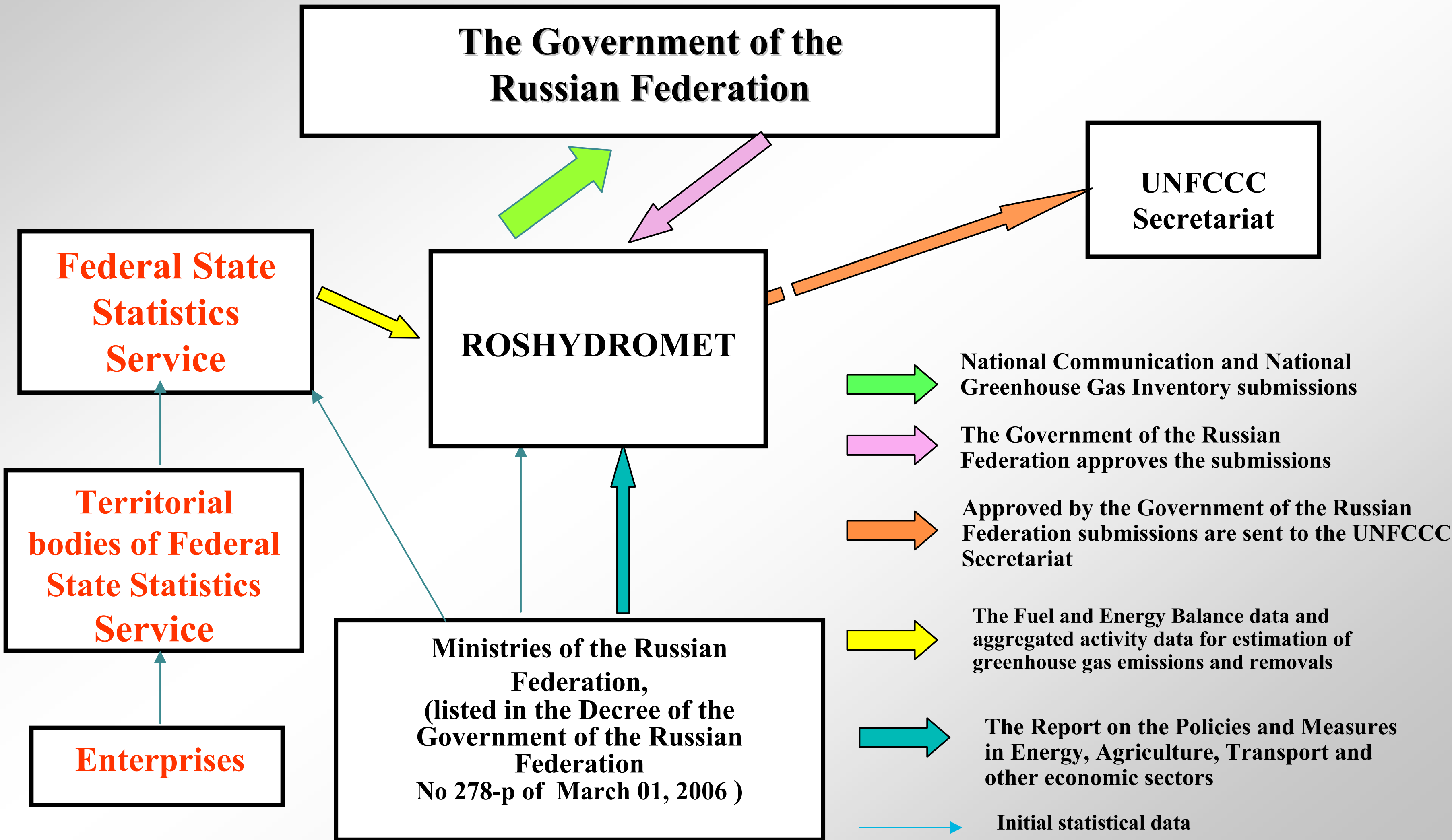
The Decree of the Government of the Russian Federation (№ 278-р, of March 01, 2006)

The Order of the Federal Service for Hydrometeorology and Environmental Monitoring (*Roshydromet*)
№ 141 of June 30, 2006

On the Approval of the Practice of Organization and Functional Implementation of the Russian System for the Estimation of Anthropogenic Emissions by Sources and Removals by Sinks of the Greenhouse Gases

List of statistical report fords for calculation of cadastre of greenhouse gas emissions

The Organization Scheme of Russian National System for the Estimation of Anthropogenic GHG Emissions by Sources and Removals by Sinks



Within the frames of its responsibility, *Rosstat*

Forms and publishes official statistical information on social, demography and environmental situation in the country

Guides the activities of ministries and agencies on development of state statistic resources

Develops a Federal Plan of statistical works on inter-agency basis including *inter alia* activity data for greenhouse gas anthropogenic emissions calculations

Provides the quality of initial statistical data and undertakes quality control of basic statistical data used by *Roshydromet* for greenhouse gas anthropogenic emissions estimation


Information flows
President of the Russian Federation, Federal Assembly of the RF, Government of the RF
Roshydromet, Ministry of Energy and Industry, Ministry for Economic Development and Trade, other government bodies
International organizations
Other users
5
Rosstat
4
3
Rosstat official publications
- Protection of the confidential data
- Data archiving, storage and protection
- Control of the aggregate output data
- Collection of data from regional Rosstat bodies
Rosstat Main Processing Center
2
- Quality Control of aggregated data
- Archiving, storage and protection of confidential data
- Quality and accuracy checks for the input data
-Activity data collection
- Collection and processing of data reccives from enterprises
1
Objects of observation
Territorial bodies of Federal State Statistics Service

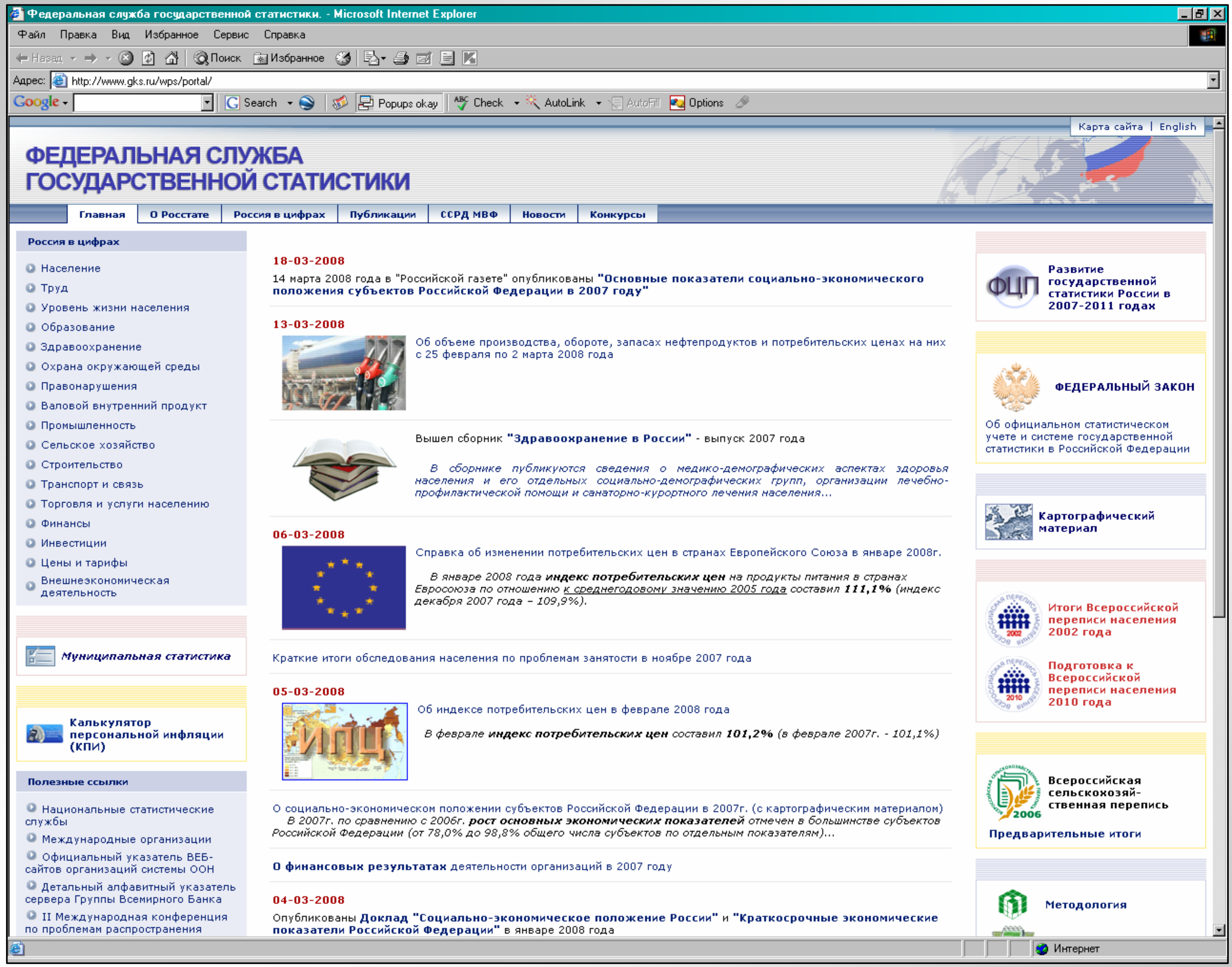
ROSSTAT OFFICIAL STATISTICAL PUBLICATIONS

Official statistical publications include **20-23 issues per year**

Periodic publications (information and analytic al materials annually published as **20-25 various statistical journals, reports and bulletins**)

Electronic copies of publications are available through Internet Rosstat web-site **www.gks.ru** all information is free

14 April 2008, Oslo, Norway



http://www.gks.ru

14 April 2008, Oslo, Norway

The *Rosstat* competes and provides to *Roshydromet* the following data on greenhouse gas:

Fuel and energy data

- The Fuel and Energy Balance
- Production in fuel and energy sectors. Basic products output

Other branches of Industry (production)

- Ferrous metallurgy
- Non-ferrous metallurgy
- Chemical and petrochemical industry
- Manufacturing and metal processing
- Forest, wood processing and pulp and paper industry
- Construction industry

Transport

- Cargo turnover (by transport type)
- Pipeline transport data (oil, gas and oil products)

Agriculture

- Agriculture production
- Agricultural crop areas
- Fertilizer input and chemical land reclamation
- Agricultural livestock and poultry population by type and by holding category
- Consumption of food products

Forestry

- Forest restoration
- Development of protection shelter belts (erosion-, pasture- and field protection)
- Forest fire data

The provision of information and data for calculation of greenhouse gas emissions performed by the other executive power bodies in accordance with their competence

- Federal Real Estate Cadastre Agency

Land use

- Land distribution by categories

- Federal Forestry Agency

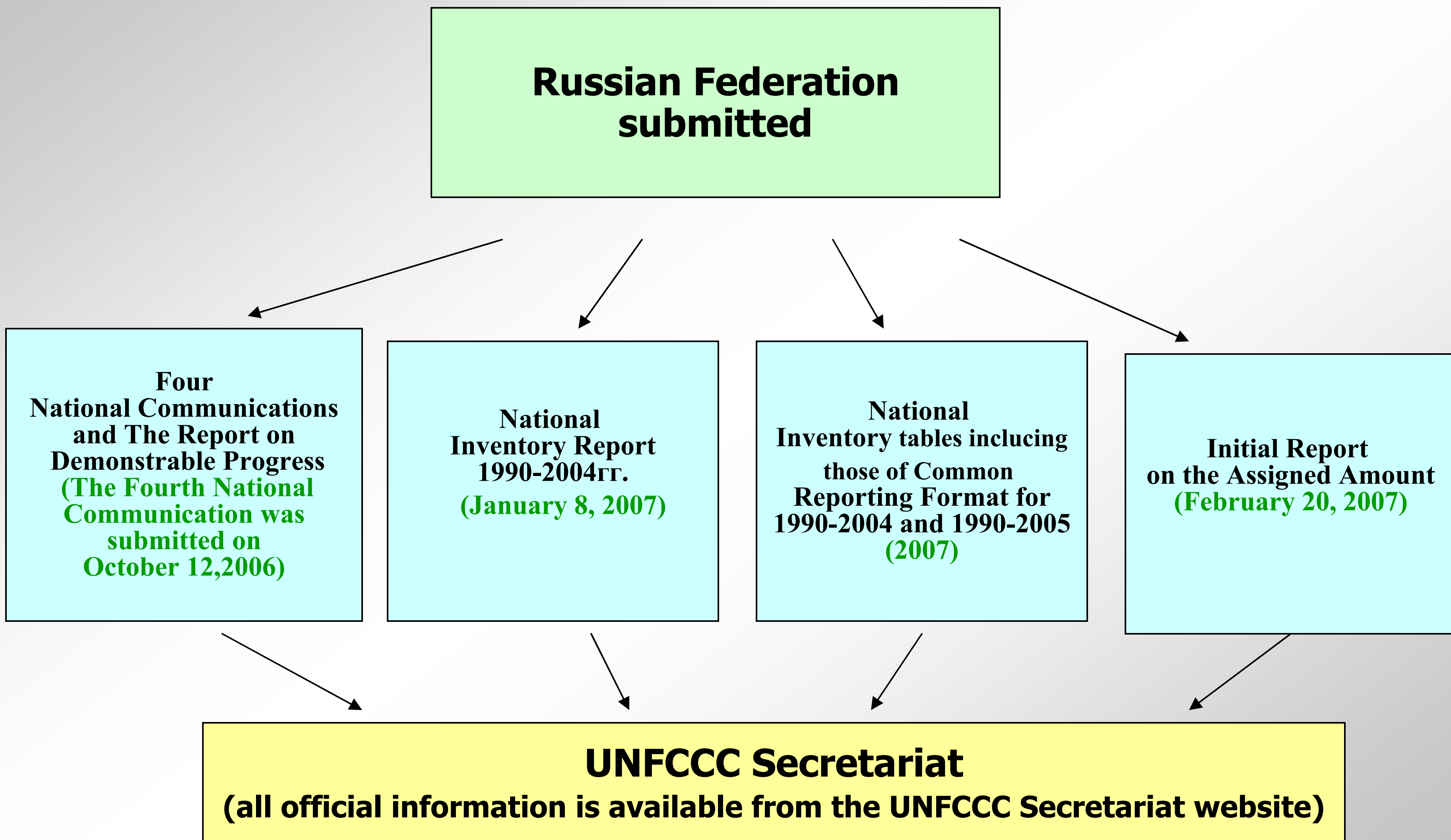
Forestry

- State forest fund data
- Main cuts data
- Management and selective cuts data

- Federal Agency for Technological Control

Waste

- Industrial and municipal waste formation, utilization, sanitation and storage


Russian Federation submitted
Four National Communications and The Report on Demonstrable Progress (The Fourth National Communication was submitted on October 12,2006)
National Inventory Report 1990-2004гг. (January 8, 2007)
National Inventory tables inclucing those of Common Reporting Format for 1990-2004 and 1990-2005 (2007)
Initial Report on the Assigned Amount (February 20, 2007)
UNFCCC Secretariat
(all official information is available from the UNFCCC Secretariat website)

The domestic problems to be solved:

The temporary lack in the official statistics of the detailed data on greenhouse gas emission and removal estimates for some key categories:

- Number of probe oil and gas wells,
- Total length of medium and low pressure gas distribution network,
- Fuel used for international aviation and marine bunkers,
- Distribution of solid and liquid municipal waste by type

and some others…

14 April 2008, Oslo, Norway

The problems, common for all countries:

- the difference between the classification by kind of activities and production types in the IPCC methodology and applied by the UN Statistics Division and Eurostat for economic activity data collection. In particular, this refers to energy and extraction industries, agriculture and land use;

- the structural differences between the IPCC and IEA methodologies for greenhouse gas emission calculations as well as the approaches for fuel and energy balance construction.

  The latter requires specific conversion factors for enhancement of calculation results.

- Absence of list of fluorine containing products, which should be used in data collection on production, export and import for calculation of emissions of HFCs, PFCs and SF_6.

14 April 2008, Oslo, Norway

Благодарю за внимание!
Thank you very much

Macroeconomic modelling for energy and environmental analyses

Brita Bye
Senior Research Fellow
Research Department
Statistics Norway

Contents

- Background
- The interlinked macroeconomic Computable General Equilibrium model (CGE-model)
- Calibration and data requirements for the interlinked CGE model
- Examples of climate policy analyses
- Future challenges

Background

- Multi sectoral general equilibrium models
  - Early approach (Johansen, 1960)
  - Current model, MSG-6, Heide et al (2004)
- Resource statistics (energy and environment, 1980-ies)
- Interlinked Economy-Energy-Environment models since 1980-ies
- Regularly used by the Ministry of Finance and Statistics Norway for long term forecasting and policy analyses
- Consistent framework for emission projections and evaluation of climate policies
  - Economic welfare effects

The CGE model MSG-6

- General equilibrium model – equality in all markets in every period
- Detailed description of the production and consumption structures of the Norwegian economy, (60 commodities, 32 private industries, 19 consumer goods)
- Small, open economy characteristics (given interest rate, world market prices etc)
- Determines domestic production, consumption, export and import given the economy's resource constraints
- Reallocation of resources between industries and from leisure to labour
  - Measure economic welfare effects of different policies

MSG-6; an interlinked economy-energy-environment model

- Detailed description of the use of energy by producers and consumers
  - Stationary (electricity, fossil fuels)
  - Transport (diesel, gasoline)
- Detailed description of production of energy mirroring Norway's special situation as a large producer of energy
  - Electricity produced by hydro power or new gas power production
  - Extraction, production and export of oil and gas from the petroleum reserves in the North Sea and the Barents Sea
- Detailed description of emissions to air
- Current carbon taxes are specified in the model
- Environment not in the objective function

Calibration of MSG-6

- The economic model MSG-6 is calibrated to the National Accounts (NA)
- Empirical benchmarking of parameter values
  - Base year benchmarking to NA
  - Estimated parameters (consumer demand system using consumer survey data, production technology using NA)
  - Other relevant parameters from microeconometric analyses
- Technology is described by the base year NA
  - Only existing technologies are represented in the model
  - If new technologies are to be introduced (gas power, bio fuels in transport etc) this description must be changed

Calibration of MSG-6: Emissions

- Two sources of energy data
  - Energy data in NA based on value terms (Million NOK)
  - Energy data from the Energy Statistics are based on physical terms, (Twh, tons etc)
- Environmental statistics
  - Emission data based on Energy statisics and other sources (tons, ppt)
- Emissions data are linked to relevant economic variables in the economic model
  - 6 green house gases and
  - 6 other gases with local/regional effects
  - Calculates base year emission coefficients
- Emission model integrated part of the MSG-6 model

Figure 1. Data input to the CGE-model

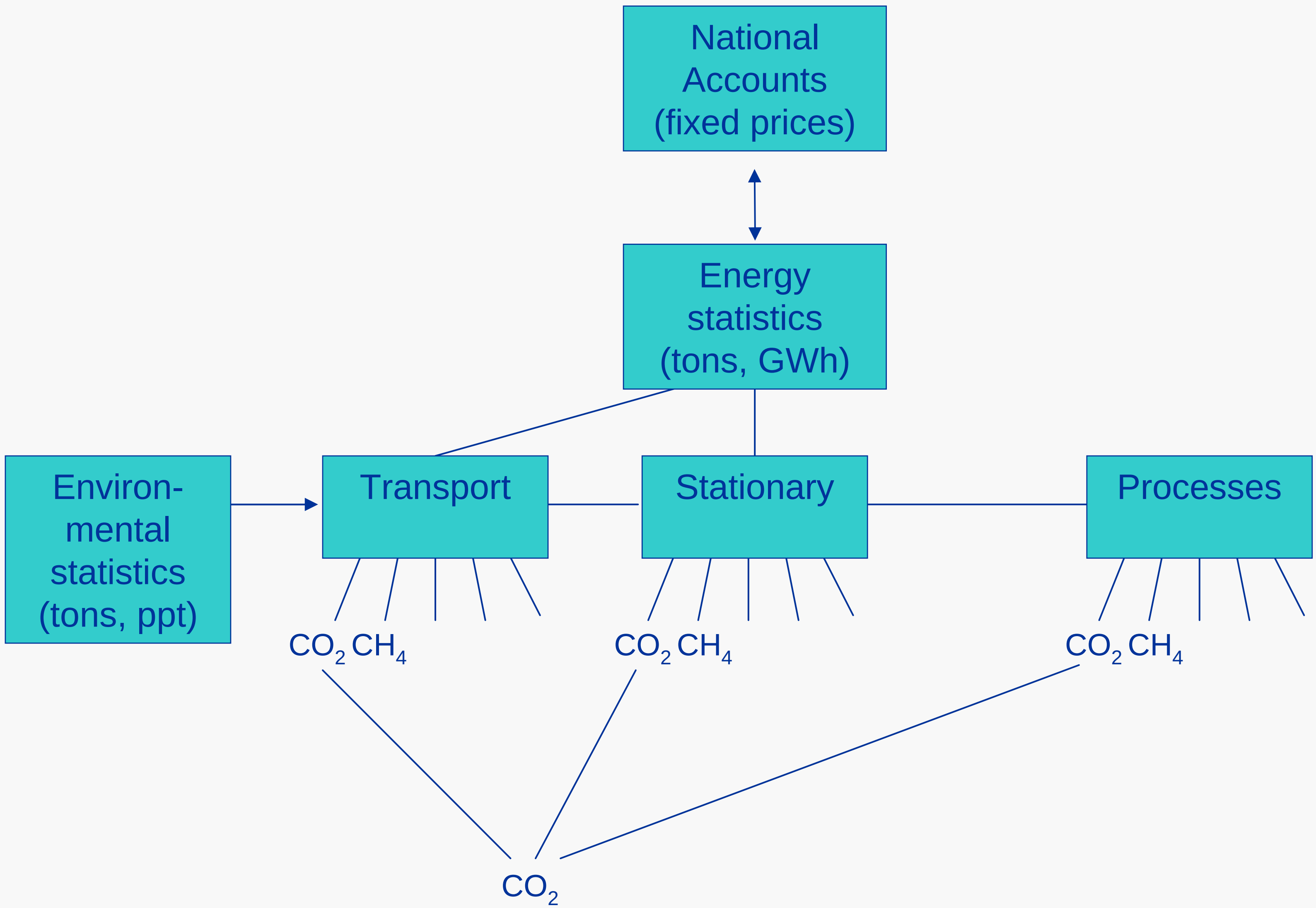


Figure 2. CGE-model

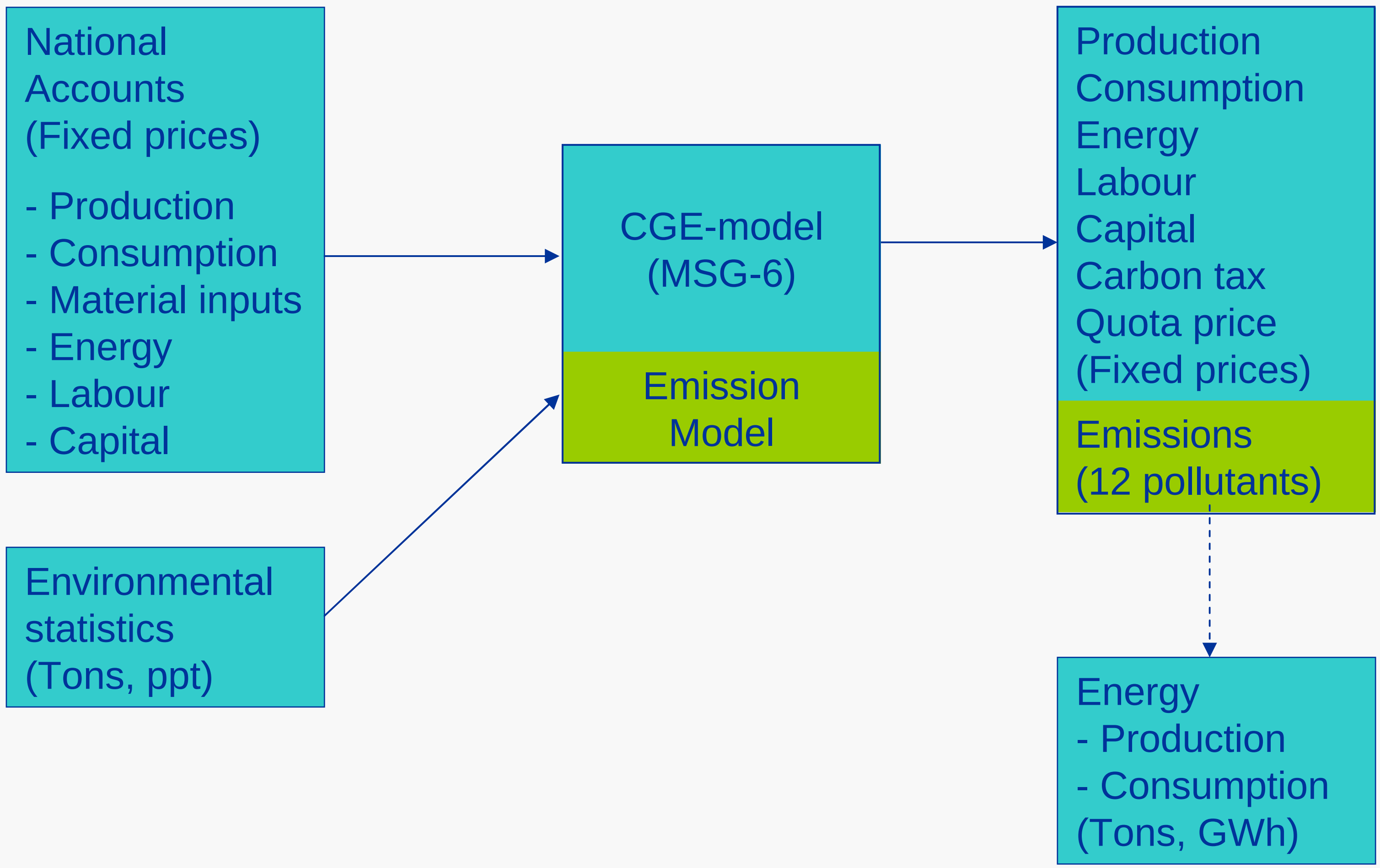


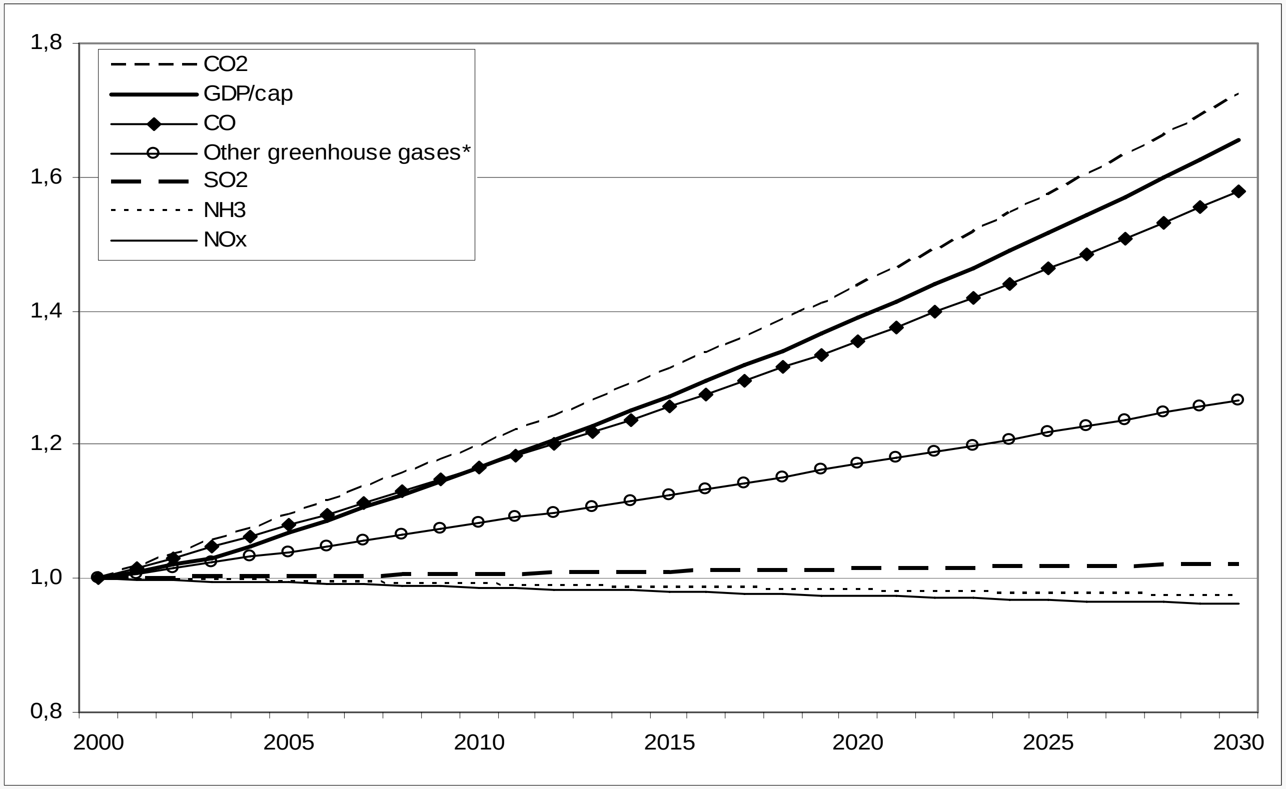
Table 1: Air pollutants and important sources in MSG-6

Pollutant	Important sources MSG-6 industry in parenthesis
Kyoto gases	
Carbon Dioxide (CO2)	Combustion of fossil fuels (Several) Reducing agents (Manufacture of metals) Gas power generation (Electricity, Oil and Gas Extraction)
Methane (CH4)	Livestock, manure management (Agriculture) Landfills Production and use of fossil fuels and fuel wood (Several)
Nitrous Oxide (N2O)	Fertilising (Agriculture), fertiliser production (Manufacture of Industrial chemicals) Road traffic (Road Transport)
Perflourocarbons (PFCs)	Aluminium production (Manufacture of Metals)
Sulphur Hexafluoroides (SF6)	Magnesium production (Manufacture of Metals)
Hydrofluorocarbons (HFCs)	Cooling fluids (Several)

Table 1 cont.

Other pollutants	
Sulphur Dioxide (SO_2)	Combustion (Several) Process emissions (Manufacture of Metals)
Nitrogen Oxides (NO_x)	Combustion (Several)
Carbon Monoxide (CO)	Combustion (Several)
Non-Methane Volatile Organic Compounds (NMVOCs)	Oil and gas-related activities Road traffic Solvents (Oil Refining, Road Transport, Households)
Ammonia (NH_3)	Road traffic (several) Fertilising (Agriculture)
Suspended Particulates (PM2,5 and PM10)	Road traffic (Households, Agriculture, Road Transport) Fuel wood (Households)

Projections, Business as Usual (BAU)



* CH4 and N2O.

Figure 2. *GDP per capita and domestic emissions, 2000–2030, 2000 = 1.00. Source: Bruvoll and Fæhn (2006)*

Climate policies and emission targets

- Indirect regulations
  - Carbon taxes
  - Tradeable quotas
    - Free
    - Auctioned
  - Given an emission target – what is the optimal carbon tax or quota price?
    - Can be calculated by using the interlinked MSG-6 model
    - Quality of data at all steps in the analysis process crucial for obtaining results that we can recommend

Climate policies cont.

- Direct regulations as:
  - Enforcement of technology changes
    - Changes in exogenous parameters in the emission model
    - Changes in factor productivity in the economic model
    - Not trivial (Low emission commision, Ministry of the Environment 2006)
      - New technologies and new products are not represented in the base year NA since they are non-observable from the statistician's point of view.
      - What are implementation costs?
  - Issuing of non-tradeable emission quotas
    - Implemented as direct production dependent transfers

Recent climate policy analyses

- Carbon taxation and quotas
  - Double dividend (carbon tax combined with lower labour tax), B. Bye (2000a, b),
  - Differentiated taxes vs. Grandfathered quotas, Bye and Nyborg (2003),
- Environmental Kuznets curves, trade and emission leakages
  - Bruvoll, Fæhn and Strøm (2003), Bruvoll and Fæhn (2006, 2007)
- Calculations for the Norwegian Low Emission Commision
  - Åvitsland (2006)
- Norwegian carbon quota scheme
  - Bjertnæs, Hagem and Strøm (2007), Norwegian Commision on excise taxation

Trade, carbon policy and emission leakages

- Cost efficient and strengthened domestic climate policy
  - Uniform carbon tax, increasing over time (13 Euro in 2000, 58 Euro in 2030).
  - Domestic CO_2-emissions are reduced by 25 % compared to BAU in 2030.
  - Small domestic welfare loss
- The pollution haven hypothesis is supported
  - Net leakages are positive
  - Global environmental benefits are reduced
- In **interaction** with the trade regime
  - Abatement costs to some extent shared with foreigners
  - Environmental costs imposed on foreigners

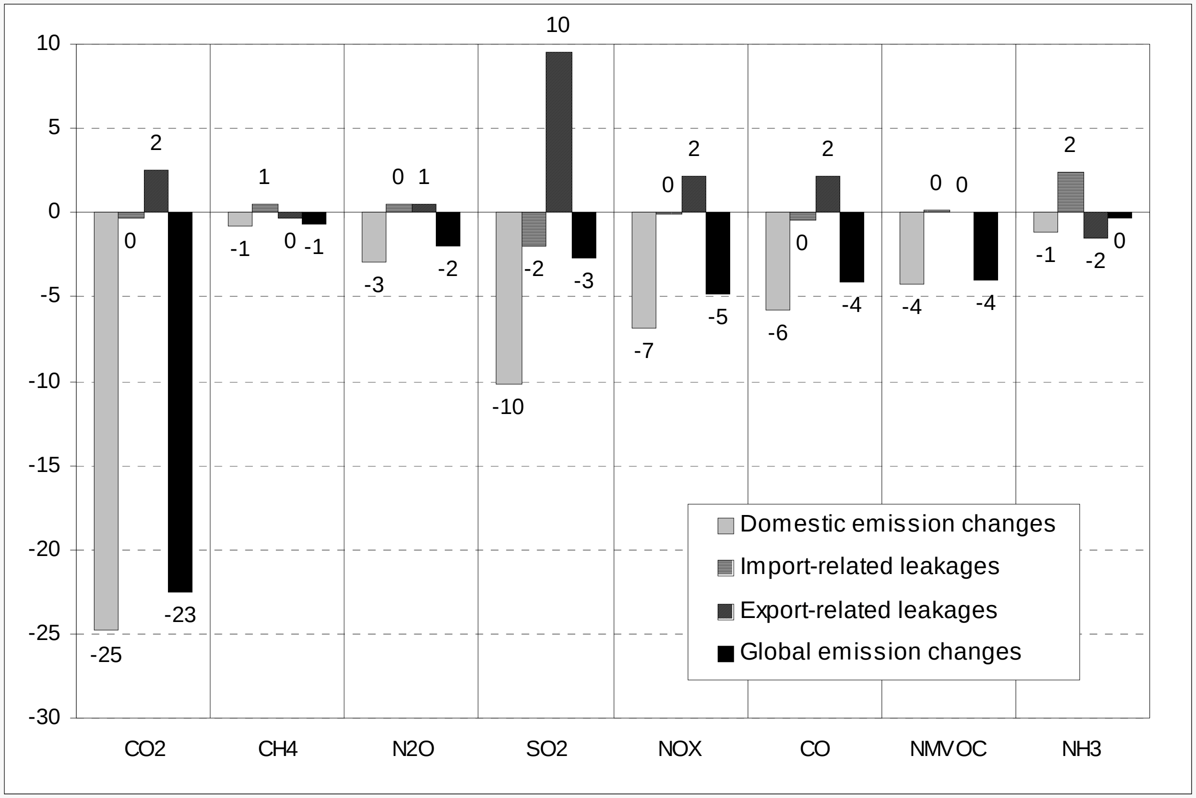
Leakages cont.

- Foreign emissions are linked to trade

  Import up -> production abroad up -> Emissions abroad up

  Export down -> substituted by foreign production -> Emissions abroad up
- Emission coefficients
  - Industry- and country specific unit emissions
  - Weights: import/export

Figure 1: Long-run changes compared to the benchmark in domestic emissions, leakages, and global emissions due to carbon taxes, in percentages.
Source: Bruvoll and Fæhn (2007)



Concluding remarks and further challenges

- Consistent and high quality data at all steps in the model building process
  - Economic - > Energy - > Emissions
- New technologies and technological change
- Modelling technological change
  - Reaserch and Development (R&D) activities are (at present) not specified in the NA
    - R&D Statistics
  - Recent modelling development at Statistics Norway includes R&D activities, general and environmental, in a CGE model
    - Bye et al (2006, 2007, 2008)
  - R&D promoting policies and carbon emission restrictions
    - Heggedal and Jacobsen (2008)

Concluding remarks cont.

- New technologies
  - How to represent new technologies (bio-fuels, Carbon Capture and Storage etc.)
- Abatement costs
  - Resources to abatement activities are not specified in the NA
  - How to measure abatement activities
    - Where are abatement activities produced and how?
- Feed back effects?
  - Transparent indicators for sustainable development preferred
- Keep the model as simple as possible!

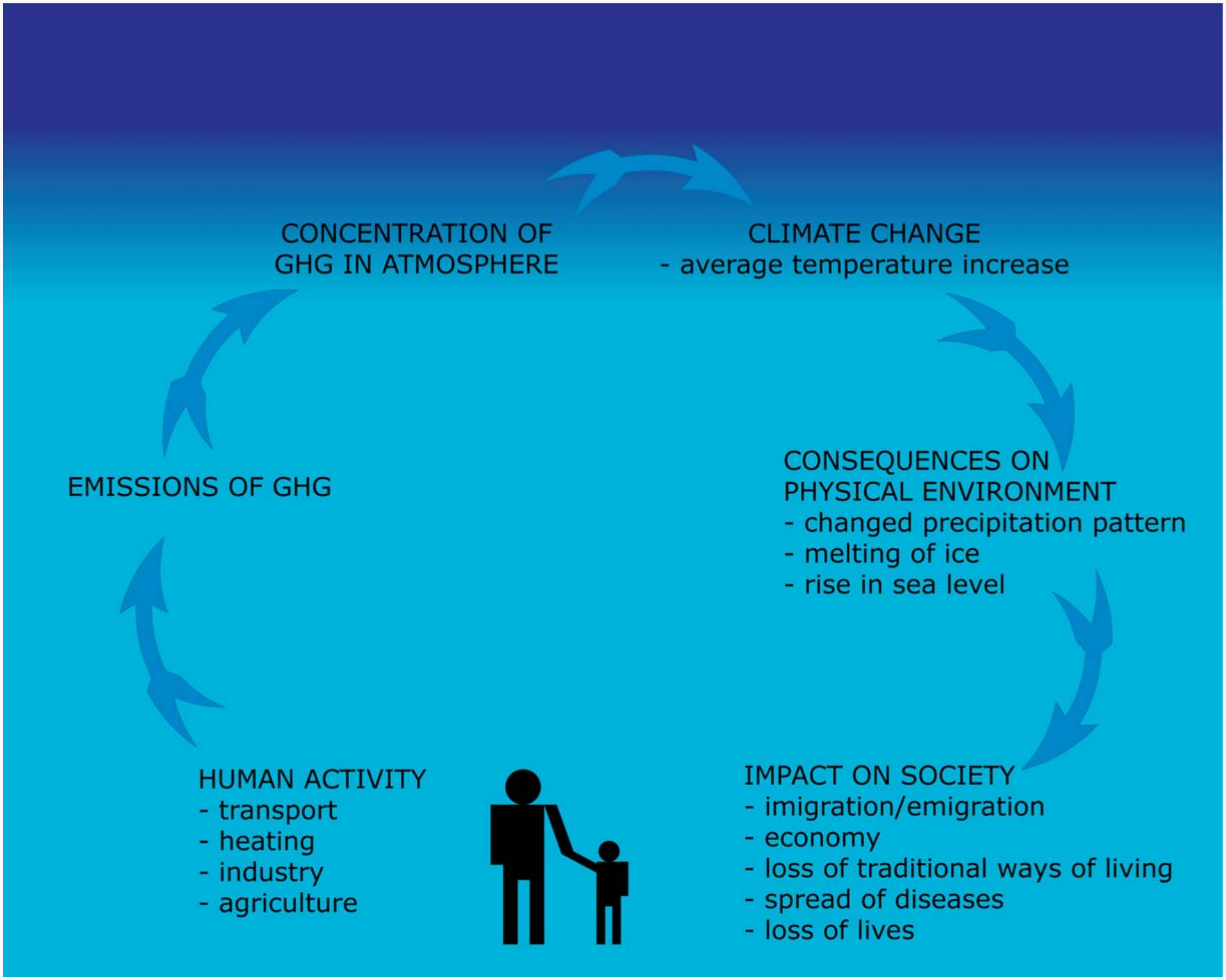
Statistics Norway
Statistisk sentralbyrå

Official Statistics on GHG emissions - the Norwegian Model

Kathrine Loe Hansen
Senior Adviser
Statistics Norway

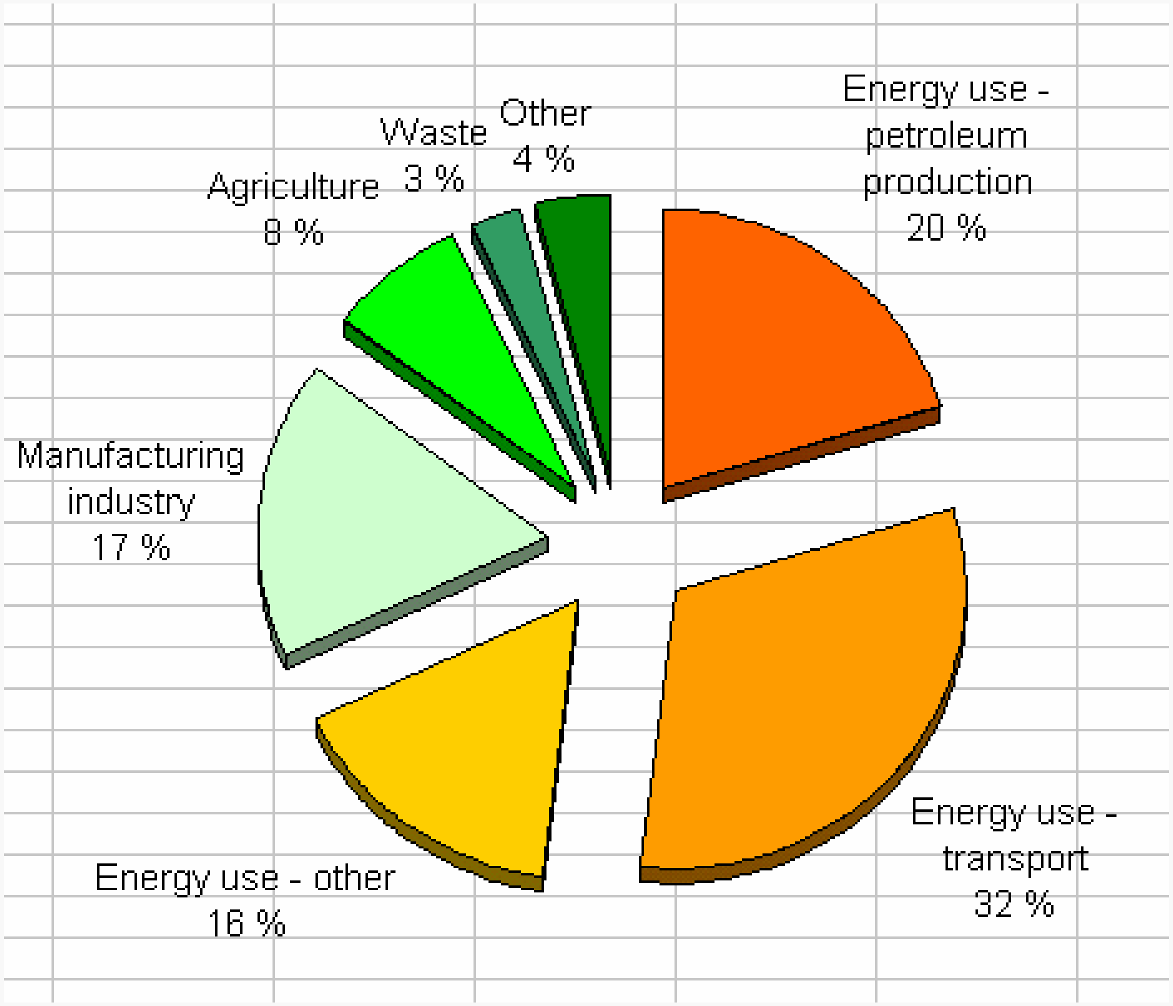
Contents

- Climate change and the (current) role of Statistics Norway
- Norwegian official GHG emission statistics
- New challenges
- Conclusions


CONCENTRATION OF
GHG IN ATMOSPHERE
CLIMATE CHANGE
- average temperature increase
EMISSIONS OF GHG
CONSEQUENCES ON
PHYSICAL ENVIRONMENT
- changed precipitation pattern
- melting of ice
- rise in sea level
HUMAN ACTIVITY
- transport
- heating
- industry
- agriculture
IMPACT ON SOCIETY
- imigration/emigration
- economy
- loss of traditional ways of living
- spread of diseases
- loss of lives

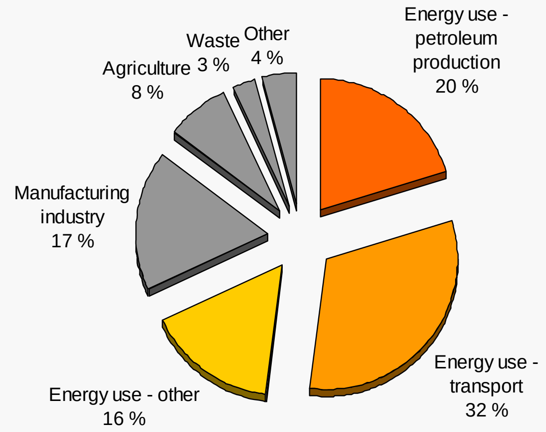
Statistics Norway
Statistisk sentralbyrå

Norwegian emission profile 2006



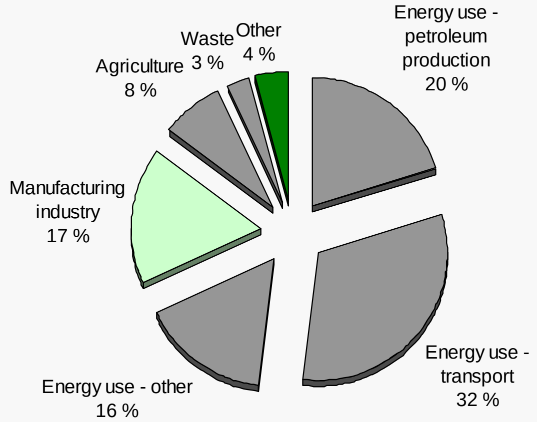
Energy production and use

- Energy and petroleum statistics
  - Energy consumption by fuel and equipment
- Transport statistics
  - Road and air transport
- Living condition surveys and consumer surveys



Manufacturing industry (and product use)

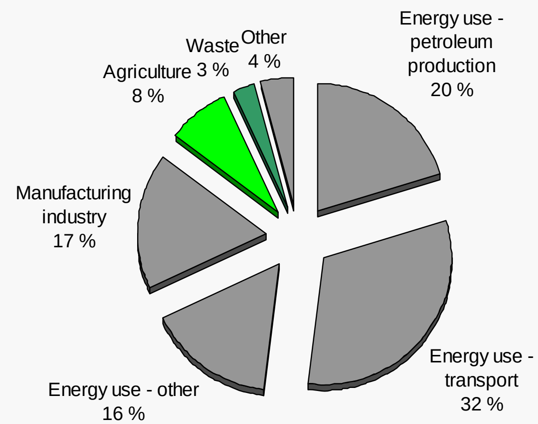
- Production statistics
- Foreign trade statistics



- **Reported data from industrial plants**
  - Replace estimated emissions
  - Source:
    Norwegian Pollution Control Authorities

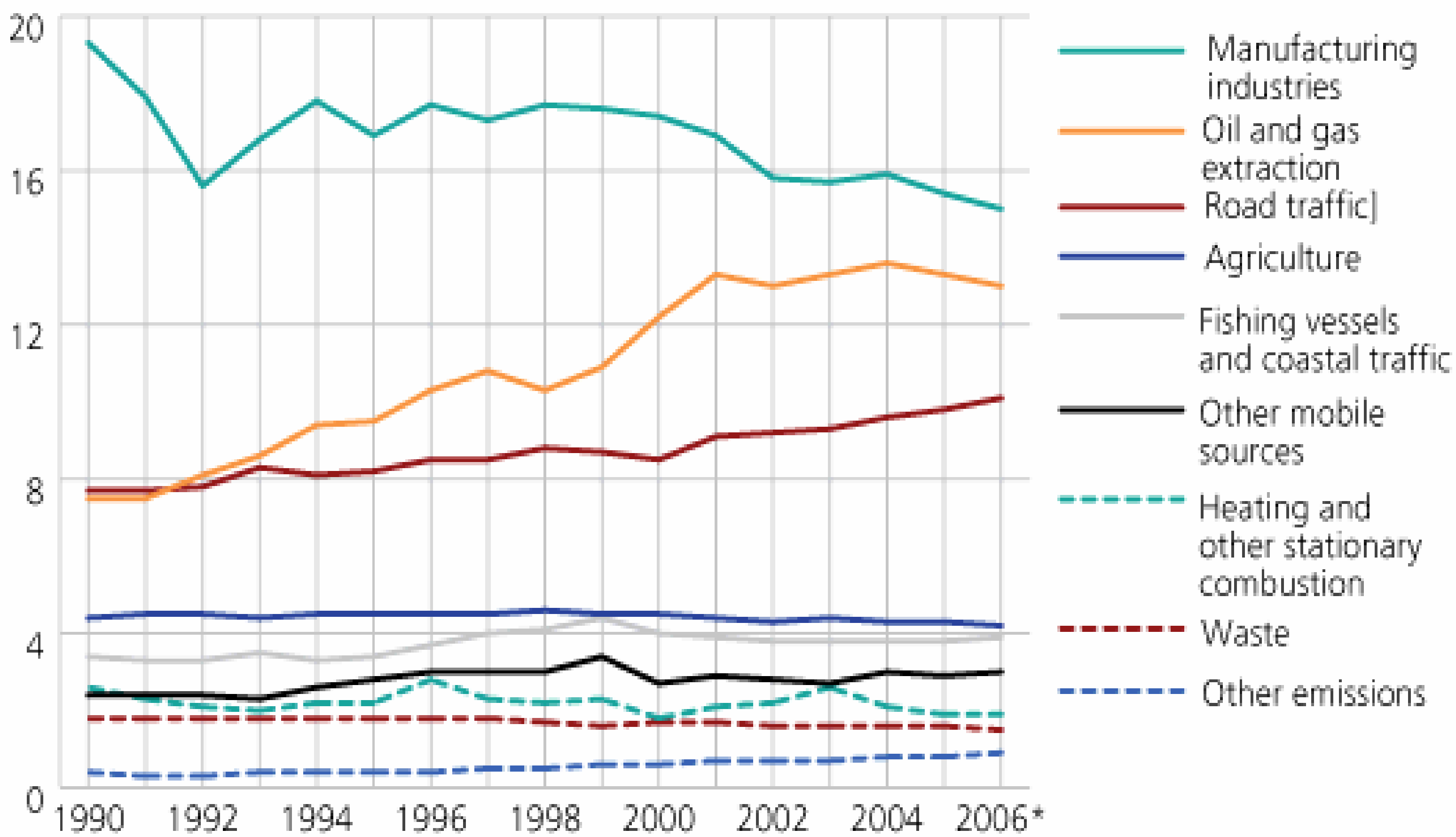
Agriculture and waste

- Agriculture statistics
  - Livestock
  - Area
- Waste water statistics
  - Fertilizer
- Waste statistics
  - Material

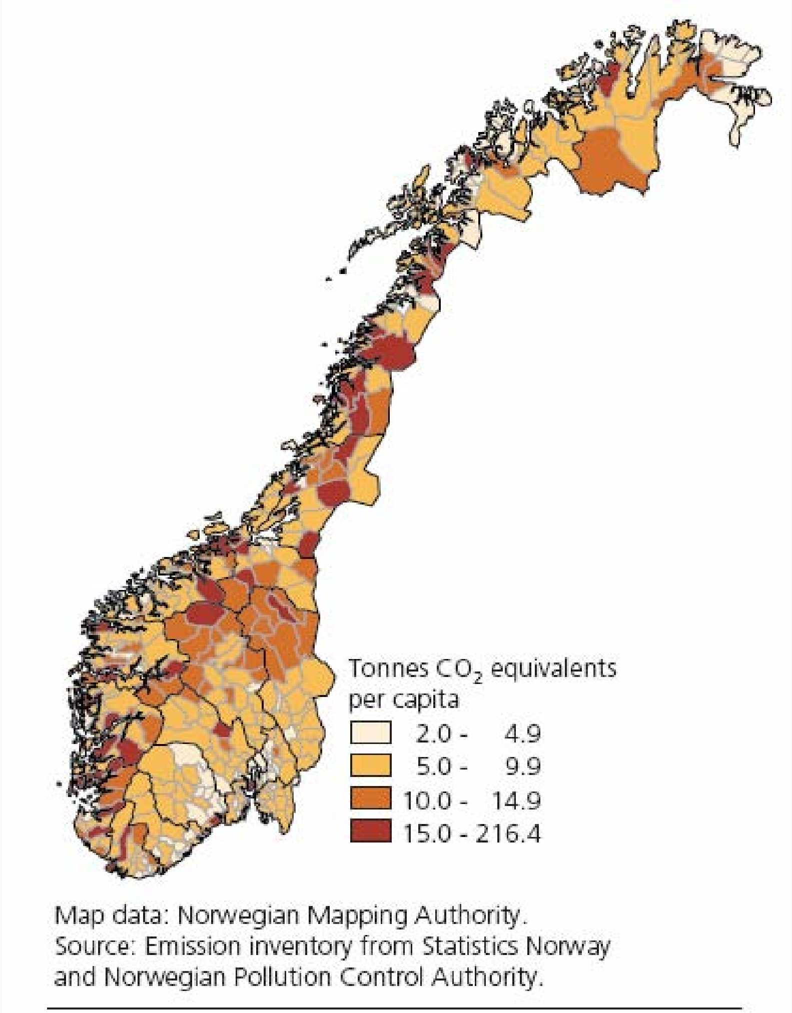


Statistics Norway
Statistisk sentralbyrå

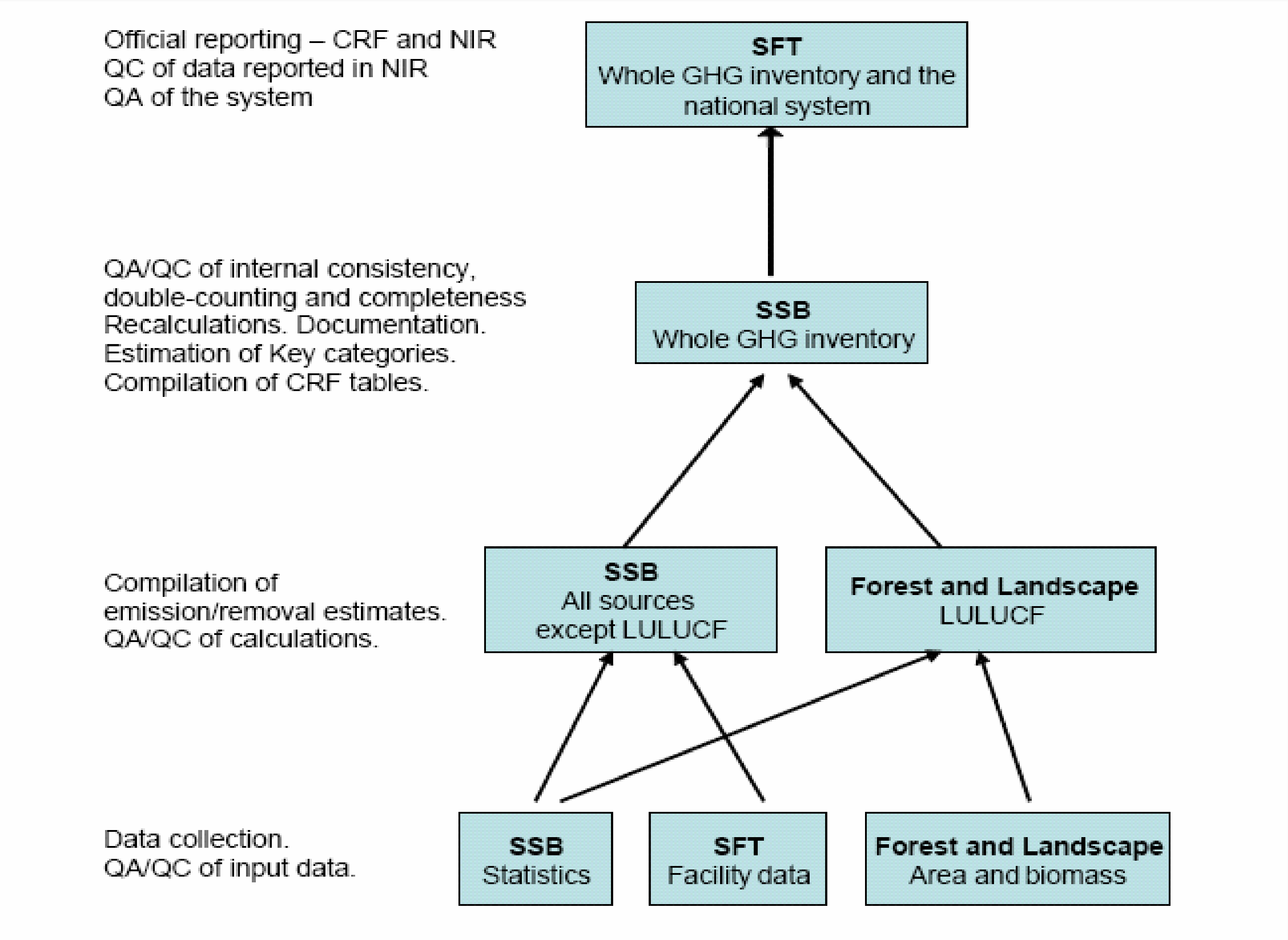
Emissions of greenhouse gases by source. 1990-2006*. Million tonnes CO_2 equivalents



Emissions by Municipality



Reporting to UNFCCC
– Institutional arrangements and cooperation



New challenges

- **Abatement**
  - Statistics on mitigation measures, carbon trading etc
- **Climate footprint** or indirect emissions
  - Imported food, clothing etc.
  - International air transport: Norwegian passengers
  - International sea transport: Norwegian fleet
- **Additional effects**
  - Impact of particles etc

Conclusions

- Statistics Norway in unique position: Trusted as independent and serious, providing the ”correct answer” on GHG emissions
- Norwegian GHG emission estimates benefit from being Official Statistics, hence high quality *also* ensured through European Code of Practice and the UN Fundamental Principles of Official Statistics
- Great advantage for emission compilers to work in close contact with the expertise on activity data used in estimating emissions, and valuable to have easy access to other data describing the drivers and structures of society
- Future work: Find resources to meet the greatly increased demand for information and provide new statistics on for instance abatement measures

Statistics Norway
Statistisk sentralbyrå

For documentation of the emission inventory, see Aasestad, K.:

The Norwegian Emission Inventory 2007
http://www.ssb.no/emner/01/04/10/rapp_emissions/

For more emission figures, see
http://www.ssb.no/english/subjects/01/04/10/klimagassn_en/

Thank you!

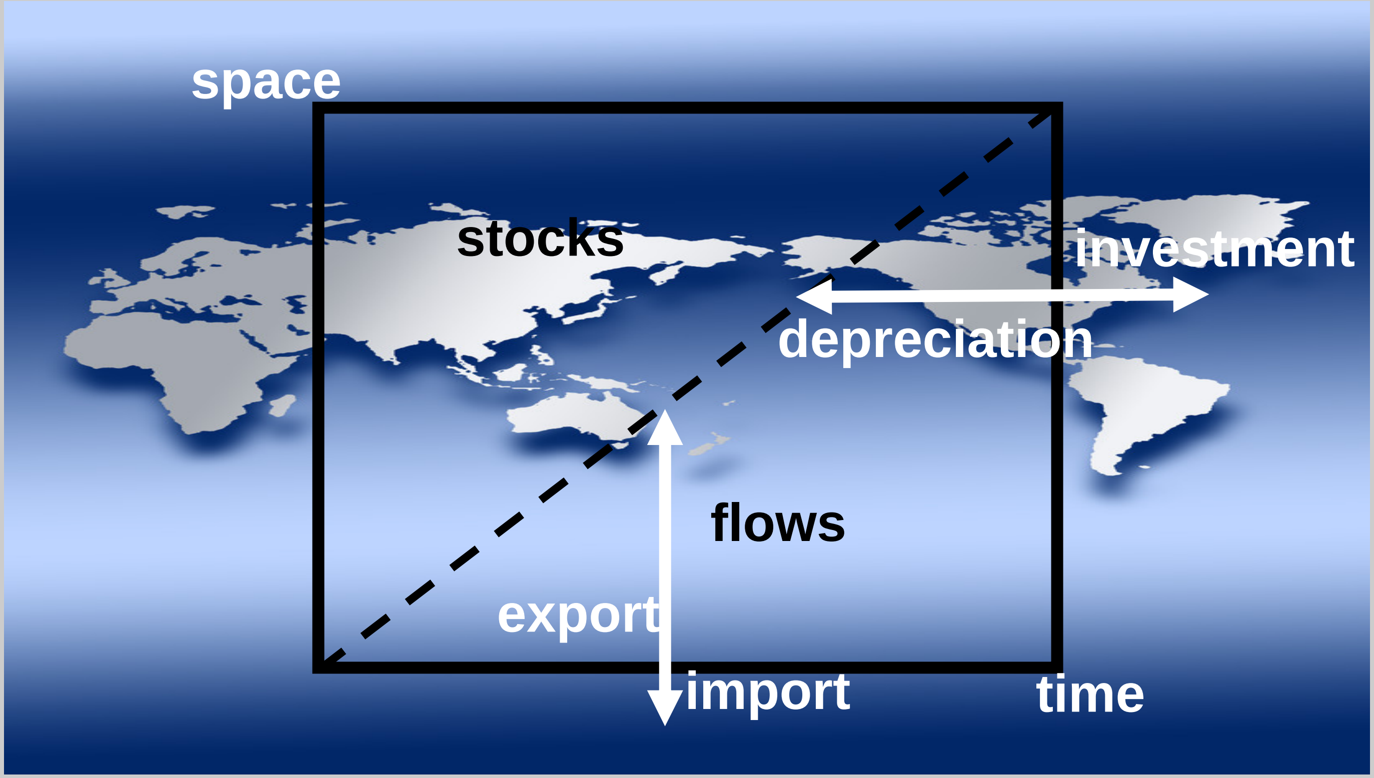
Environmental Pressures from German Imports and Exports

Embodied Energy and CO_2-Emissions of Goods

Walter Radermacher
President of the Federal Statistical Office, Germany

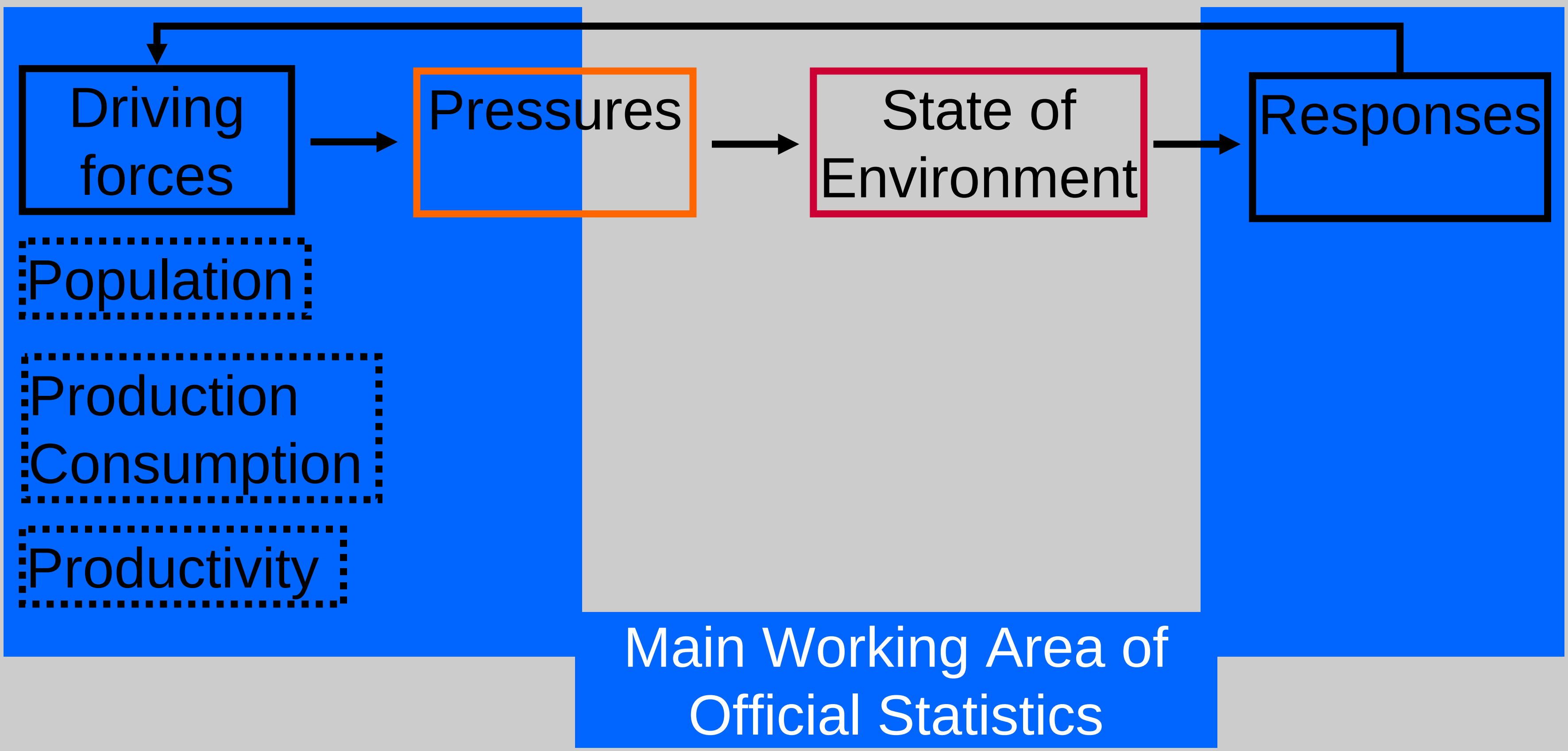
Conference on “Climate Change and Official Statistics”
14-16 April 2008, Oslo

The Economic System in Statistics: A “flat” projection

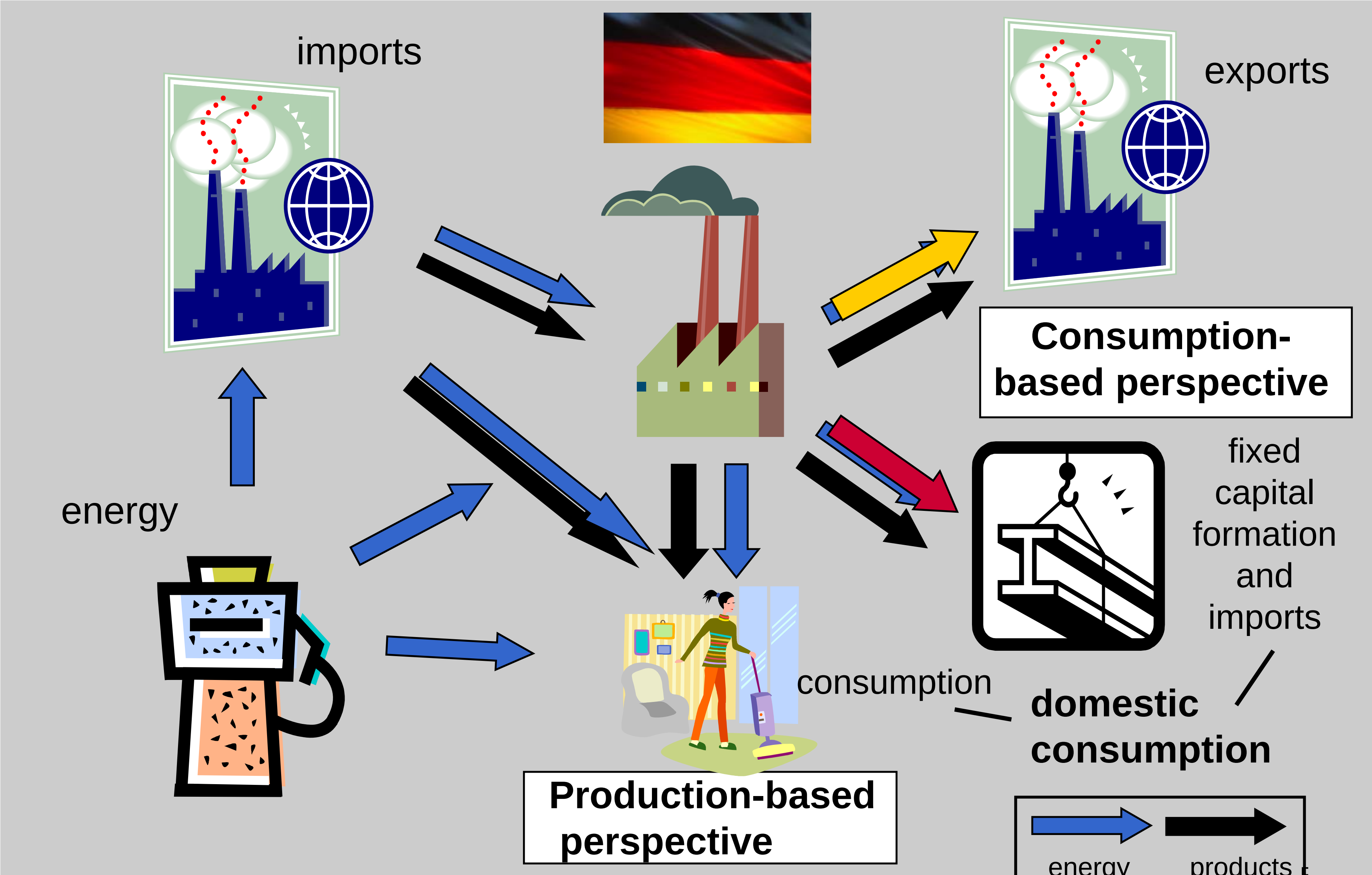


DESTATIS wissen. nutzen.

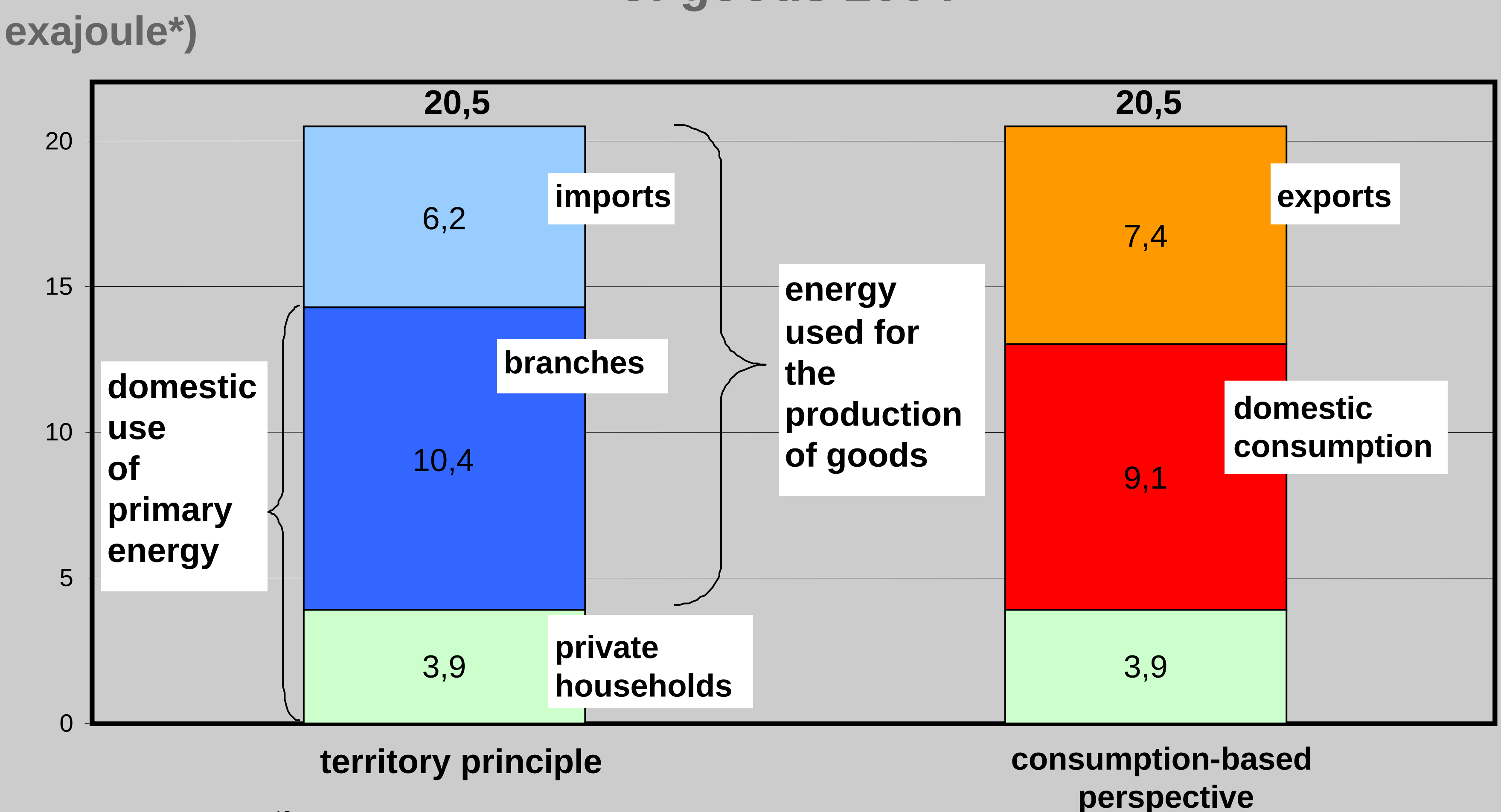
Official Statistics and Environment



Federal Statistical Office Germany



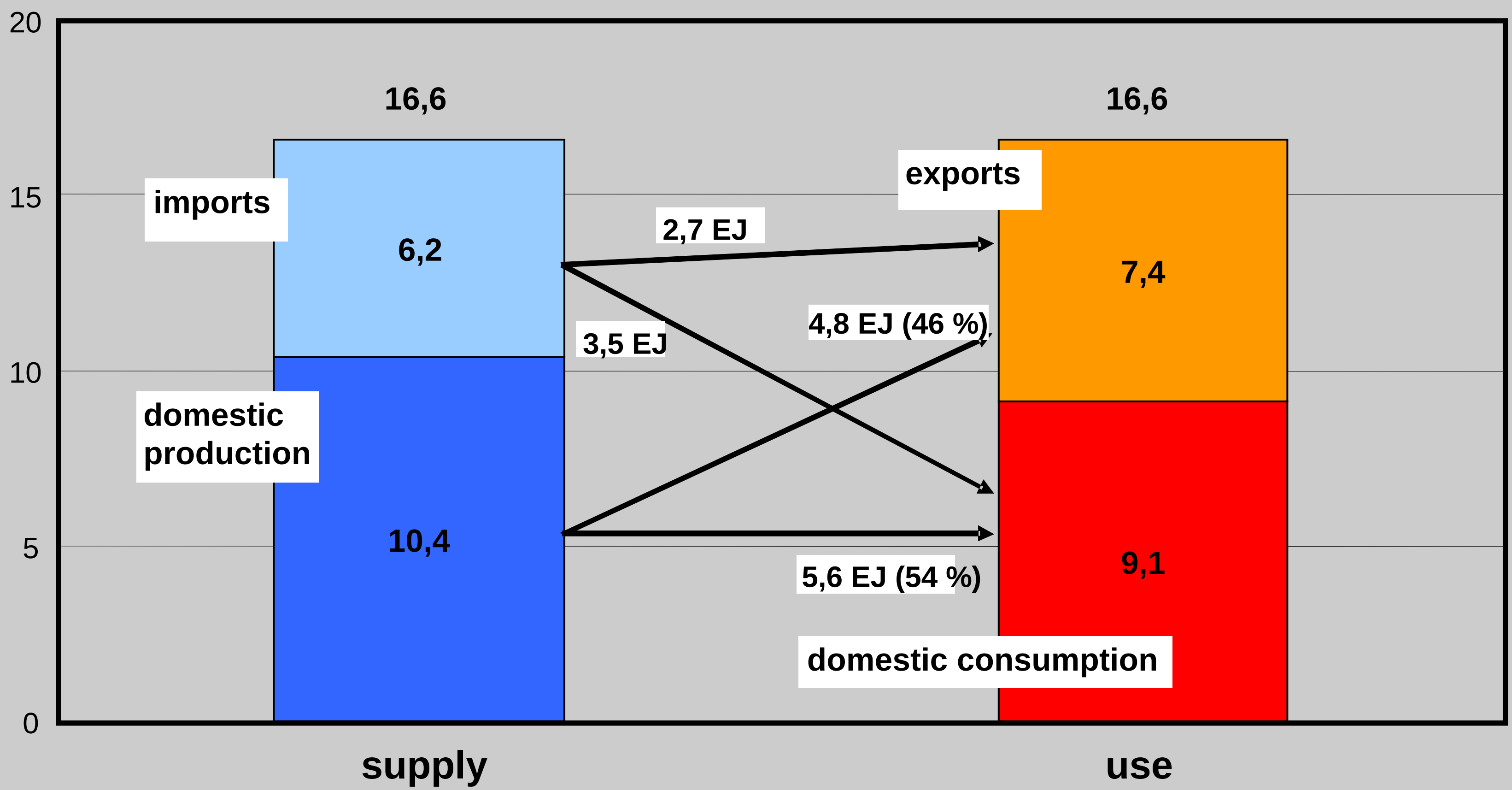
Energy consumption and energy used for the production of goods 2004



*) 1 Exajoule = 1 EJ = 10^{18} Joule

DESTATIS wissen. nutzen.

Energy used for the production of goods 2004 in exajoule *)



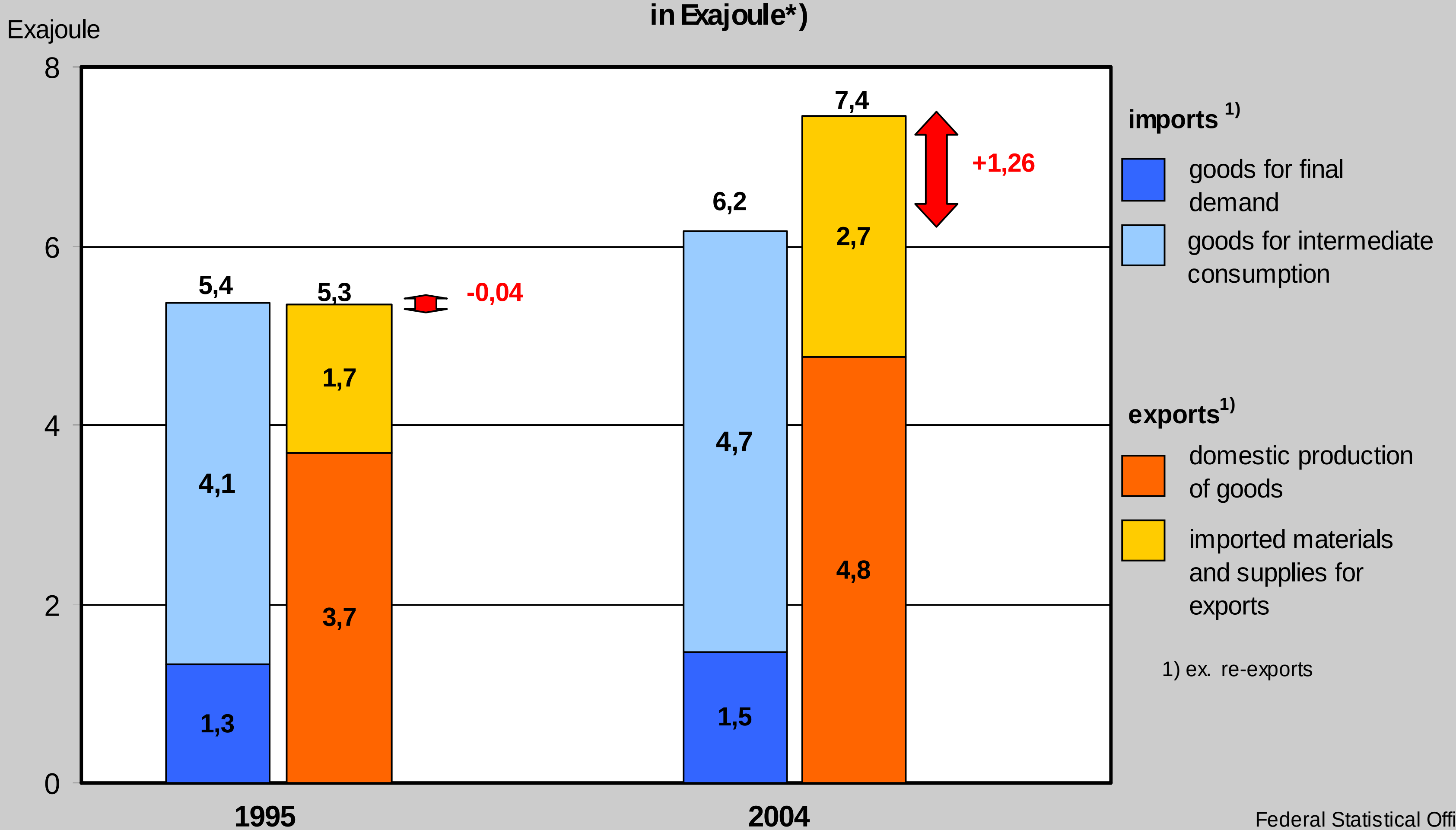
*) 1 exajoule = 1 EJ = 10^{18} Joule

Federal Statistical Office Germany

DESTATIS wissen. nutzen.

Energy content of imports and exports

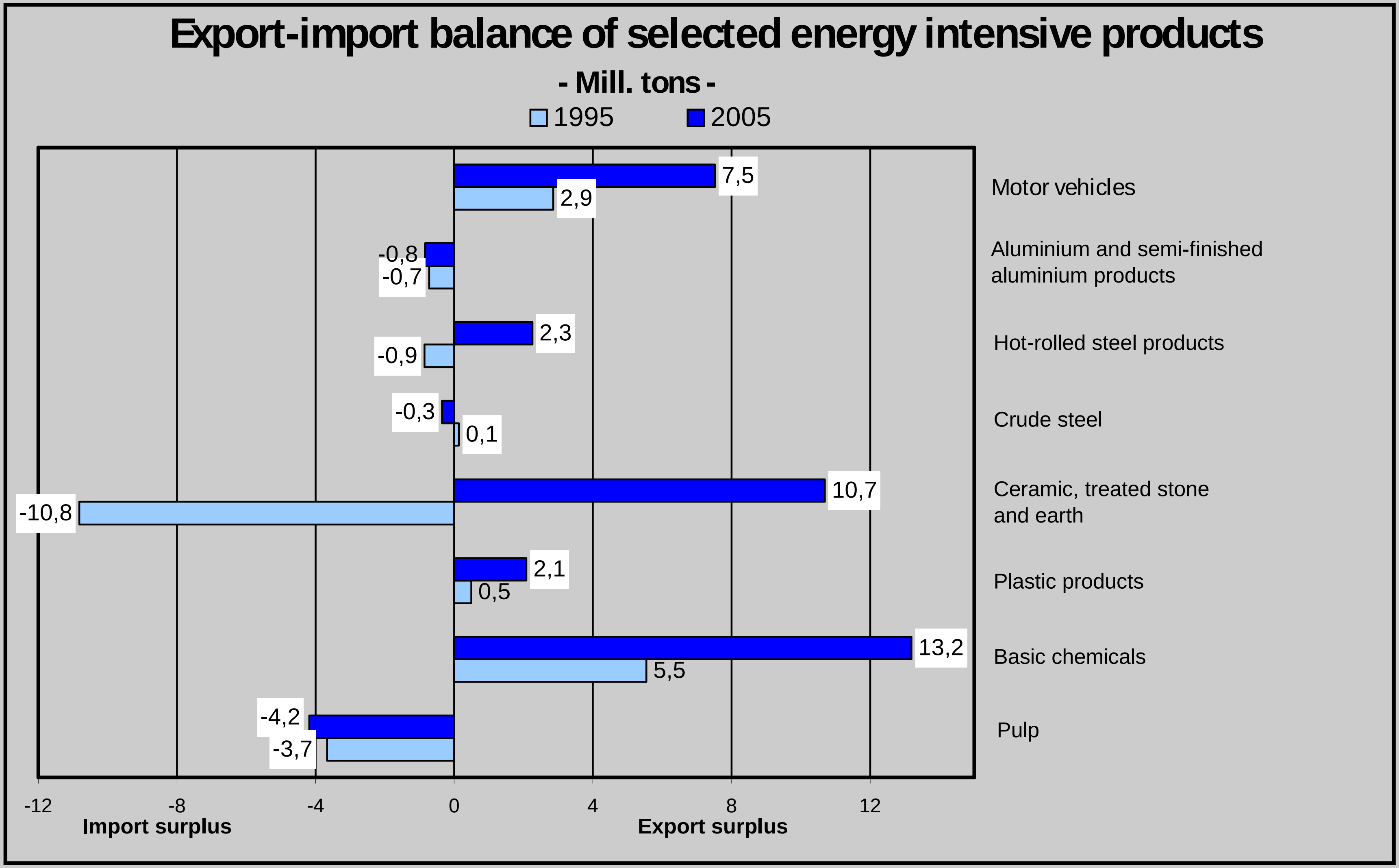
in Exajoule*)



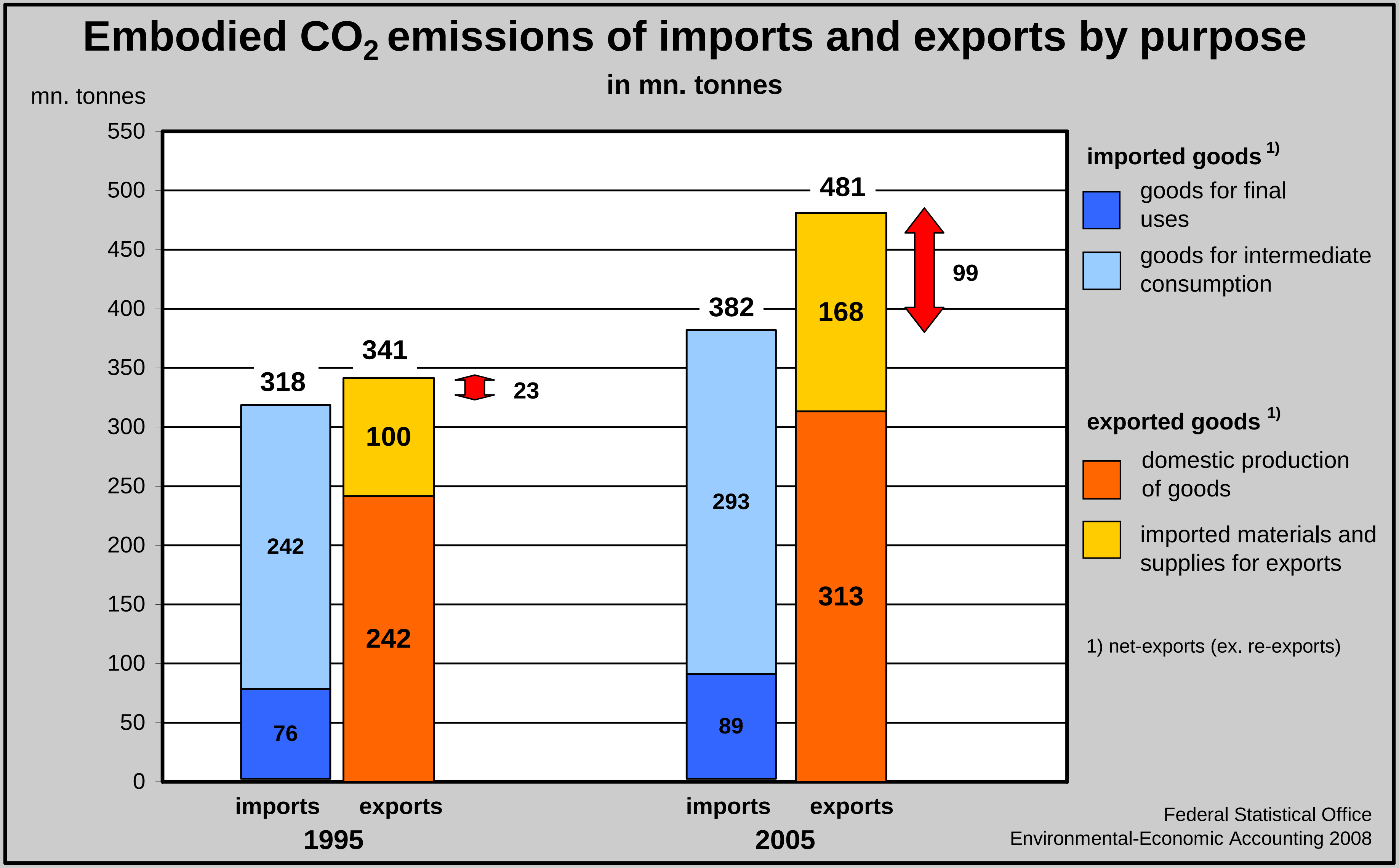
*) 1 Exajoule = 1 EJ = 10^{18} Joule

Federal Statistical Office
Environmental-Economic Accounting 2007

DESTATIS wissen. nutzen.

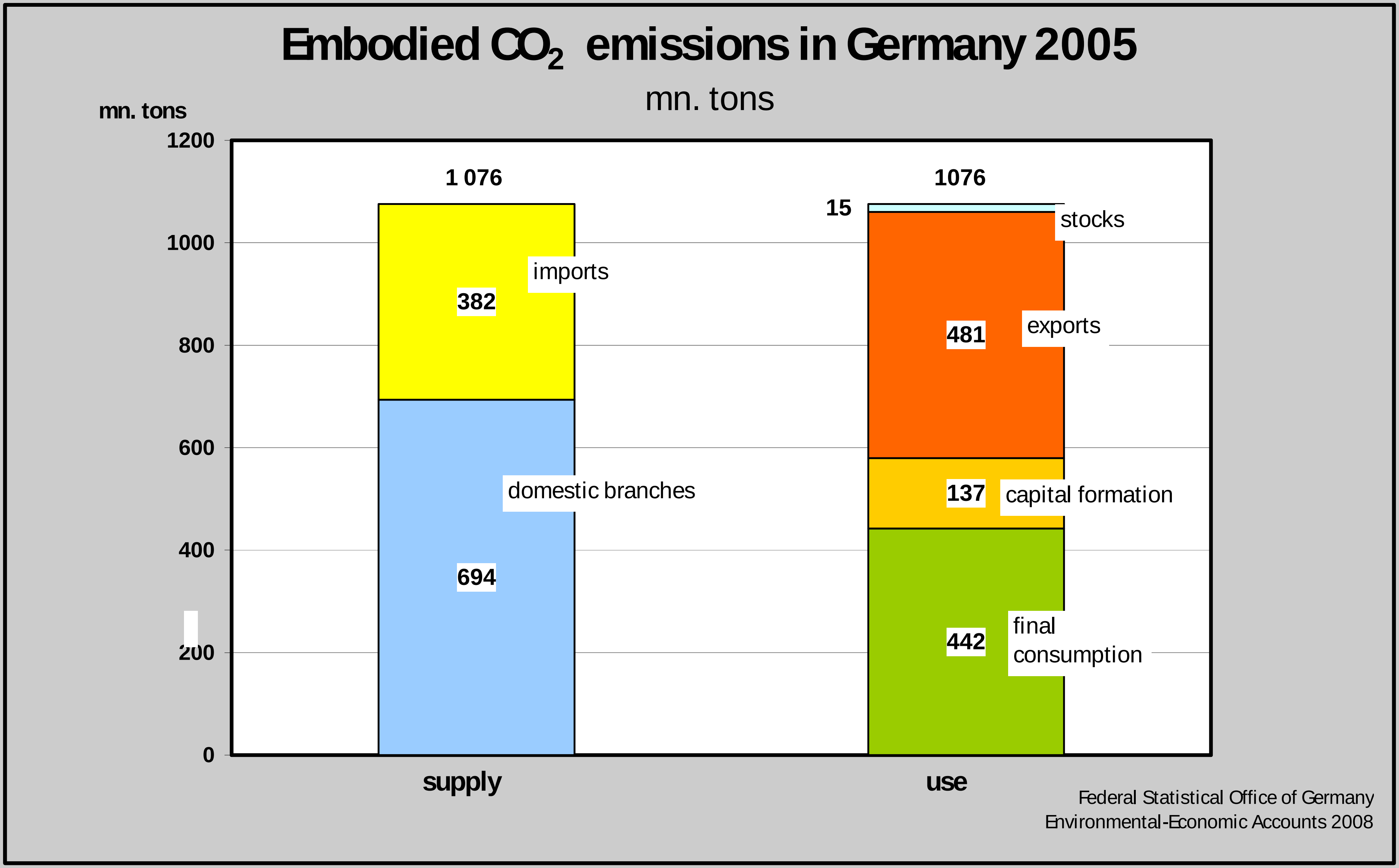


Federal Statistical Office Germany



Federal Statistical Office Germany

DESTATIS wissen. nutzen.



Messages

Energy input for production in Germany is higher than for domestic consumption

Between 1995 bis 2004 increase of energy input for export was higher than for import

Energy-intensive industries cannot be identified to be shifting abroad

CO_2 emissions are significantly higher in production of export goods than in the production of imported goods

CO_2 emissions of domestic production are by 16% higher than CO_2 emissions of domestic consumption (increasing share since 1995)

National targets for reducing CO_2 emissions should take this difference into account

Next steps for official statistics

Provide the resources for an adequate quality of official statistics

Make sure that the necessary basic data is available

Broaden the accounting systems

- environment, sustainability, R&D, human capital etc.
- core system and satellite systems

Agree on indicator sets based on available information

Develop standards/handbooks on international level

Build up databases for the analyses of transboundary flows (especially with view to the problem of climate change)

Further recommendations

- Official statistics contribute to the public debate but cannot be the only provider of information
- Make a clear distinction between tasks of statistical offices and of research institutes
- Enhance a close cooperation with science and model builders
- Intensify the working relationship between national statistical institutes and international organisations

Thank you for your attention!

Walter Radermacher

Telefon: +49 (0)611 / 75 21 00

walter.radermacher@destatis.de

www.destatis.de

Climate Change Policy and Need for Adequate Statistical Information with Special Regard to Agriculture

Conference on Climate Change
and Official Statistics
Oslo, Norway
14-16 April 2008

Éva Laczka – Tibor Faragó

Outline

- Milestones of the Hungarian Climate Change Policy
- Hungarian Climate Change Strategy
- Hungarian Agriculture
- Interaction between Climate Change and Agriculture
- Adaptation
- Information needs – how to improve it
- Conclusion

Milestones of the Hungarian Climate Change Policy

- **Climate change related research dates back 25 years**
- **1980s - the first complex studies about the effects of extreme weather patterns**
- **1990 - first strategic documents and programs**
- **2007 - National Strategy on Climate Change adopted**
- **2007 – National Forum established for coordination of research and adaptation**

Priorities of the Hungarian Climate Change Strategy (HCCS)

- **Perception: inform the social and professional partners**
- **Mitigation: achieve emission reduction**
- **Adaptation: prepare for adaptation**

Coverage and Results of Hungarian Climate Change Research

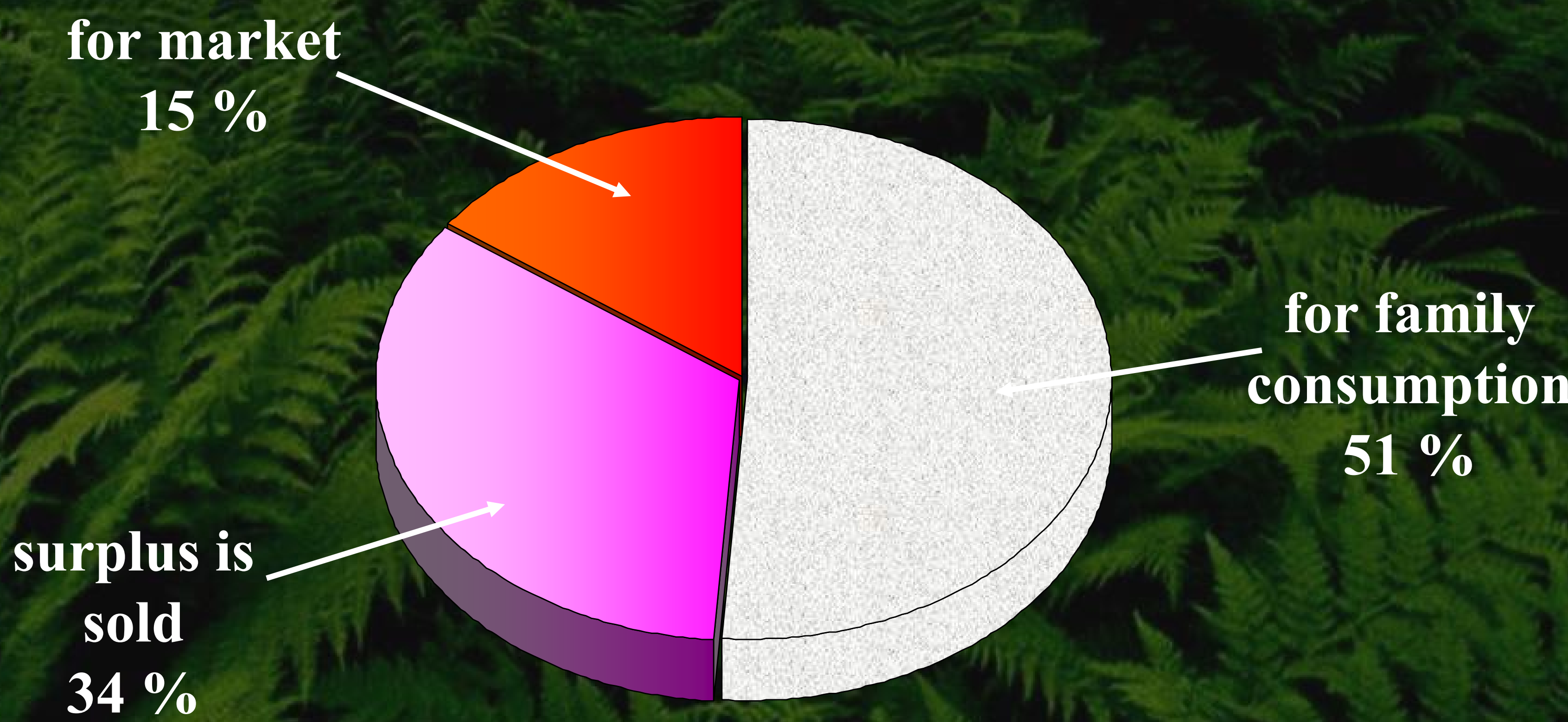
- **Environment**
- **Economy**
- **Society**
- **Human health**
- **300 publication over the past 2 years**
  - **basically examine the interaction between climate change and agriculture**

Hungarian Agriculture

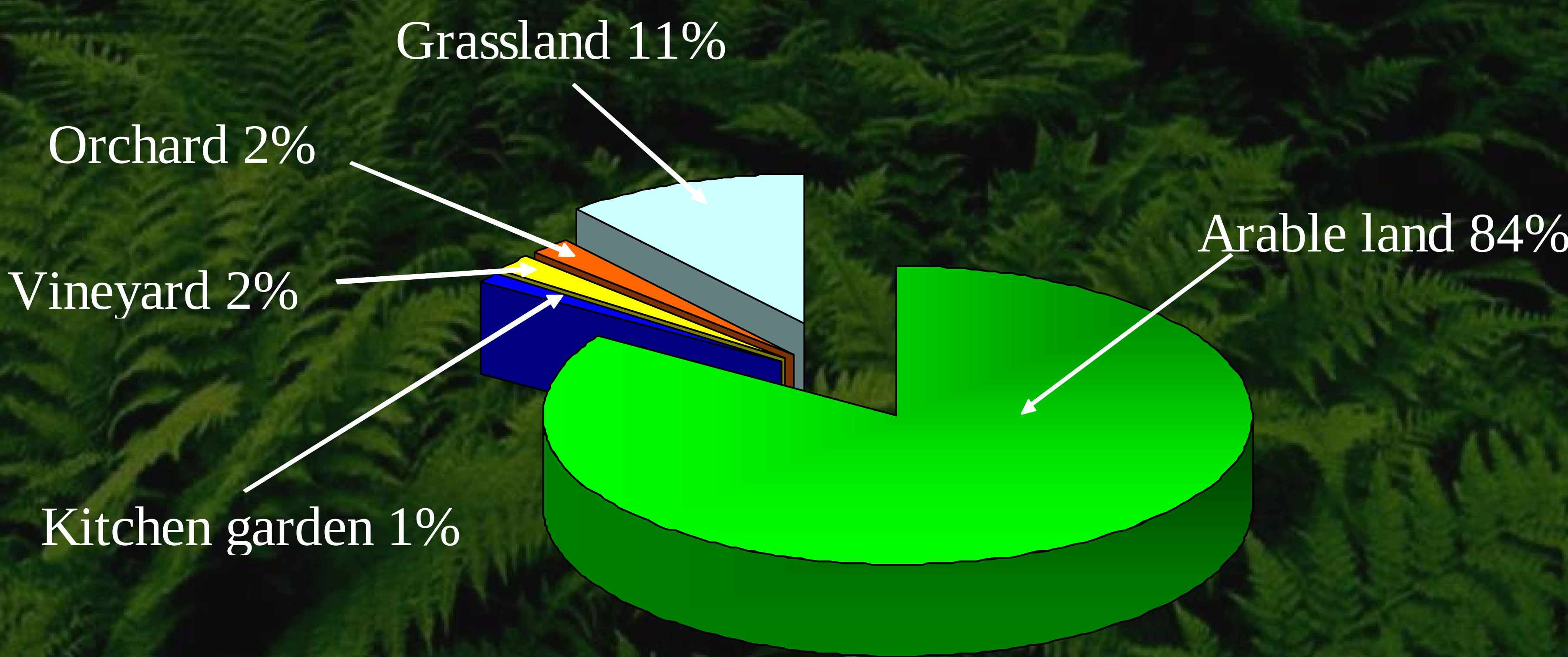
- **3-4 percent of GDP**
- **2-3 percent of export**
- **7 900 agricultural enterprises and 707 thousand private holdings**
- **One fifth of the Hungarian population is involved in some kind of agricultural activity**

Purpose of farming

Private holdings



Land Use – Crop Production



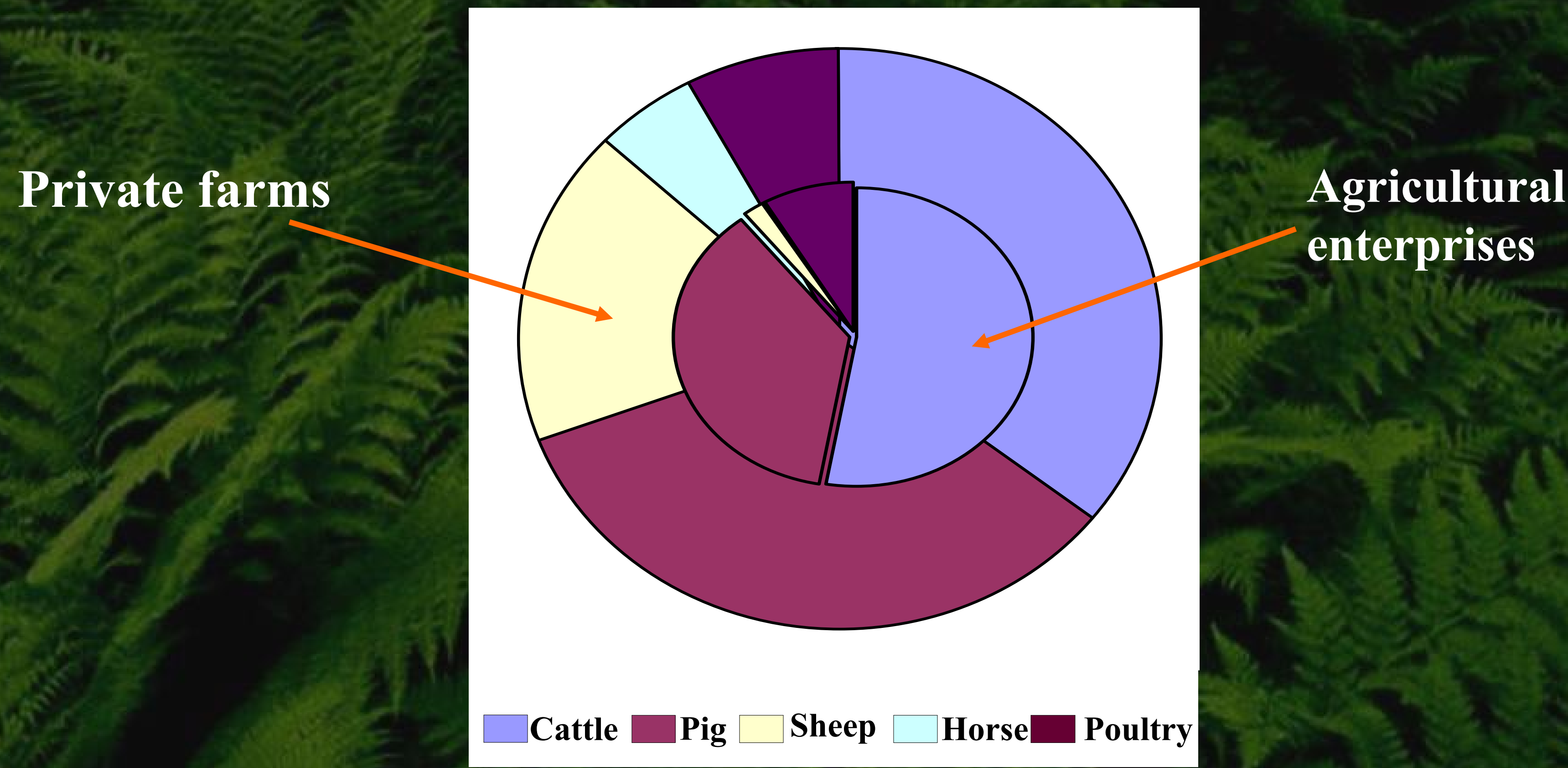
HCCS on Crop Production

- **Effects of CC on crop production**
  - **more frequent extreme weather patterns**
  - **erosion**
  - **extreme wind**
  - **spread of invasion species**

- **Effects of crop production on CC**
  - **nitrous oxide and methane emission**

- **Adaptation**
  - **decrease nitrous oxide and methane emission by water efficient and soil preserving production methods**
  - **improve production methods**
  - **limit the spread of invasion species**

Livestock unit by species



HCCS on Animal Breeding

- **Effects of CC on animal breeding**
  - **has different effects by type of animals (extensive and intensive breeding)**
  - **increasing water and shade requirement**
  - **changing nutrient content of the grass composition of pasture**

- **Effects of livestock breeding on CC**
  - **significant carbon dioxide and methane emission**

- **Adaptation**
  - **improve technology of animal breeding**
  - **increase the extensive animal breeding**
  - **increase the number of traditional domestic species**
  - **environmentally sound treatment of manure**

Forested and Green Areas

- **Forest**
  - **20 percent (1.9 million hectares) of the total area**
  - **71 percent hardwood, 13 percent softwood, 16 percent pinewood**

- **Green areas of settlements**
  - **40 thousand hectares**
  - **size of green areas has been decreasing**

HCCS on Forest and Green Areas

- **Interaction between forest, green areas and CC**
  - **play an important role in natural carbon cycle**
  - **influence the concentration of greenhouse gases**

- **Adaptation**
  - **increasing the size of forest and green areas**
  - **incorporation of strategies to the national forest program**
  - **planting species suitable for the new conditions resulted by CC**
  - **analysing the impact of energy source plantations**
  - **expansion of green areas in urban regions**

Data Sources on Agricultural Production

<u>Agricultural Censuses</u>

- 1872 Vineyard
- 1895
- 1935
- 1972
- 1981
- 1991
- 2000
- 2001 Vineyard and Orchard
- 2003
- 2005
- 2007

<u>Regular Surveys</u>

- Annually 15-20 sample surveys
- Covering:
  - Land use
  - Crop production
  - Livestock
  - Animal products
  - Prices

Weaknesses of Agricultural Production Data

- **provide limited information on production methods**
- **do not provide information by crop and animal species**
- **do not cover quality characteristics of production**
- **regular surveys provide data only at regional level**

Future Data on Agricultural Production

EU Farm Structure Survey (FSS)

- **since 2010 new regulation**
- **FSS 2010 will be a full scope survey**
- **module on agricultural production methods**

Indicators to be collected on Agricultural Production Methods

- **Tillage methods**
- **Soil conservation**
- **Actions against erosion and nutrient leaching**
- **Animal grazing**
- **Animal housing**
- **Nutrients**
- **Manure storage and treatment facilities**
- **Plant protection**
- **Irrigation**

Additional Data Sources

- **Energy use of Agriculture (HCSO + administrative data sources) → quality of data/estimation need to be improved**
- **Forestry statistics (MARD) → coverage of data needs to be improved**
- **Data on green areas (HCSO) → type of plants and cultivation methods should become subject of data collection**

Estimation of Emission Data

- **Compilation of Emission inventory is responsibility of Ministry of Environment and Water**
- **Agricultural and industrial production data are provided by National Statistical Institute (HCSO)**
- **Data on soil types and production of plant species provided by Ministry of Agriculture and Rural Development**

Measurement of Immission Data

- **Joint responsibility of Ministry of Environment and Water and Ministry of Public Health**
  - **measurements are carried out by the ministries**
- **HCSO supports the analysis by applying mathematical statistical methods**

Conclusion

- Hungarian Climate Change Strategy approved
- Responsibilities defined
- Detailed list of indicators and definitions need to be finalised
- Action plan on how to fill the data gaps
- Deepening the cooperation between the National Statistical Institute and professional organisations

Thank you for your attention!

Sourav Chakrabortty, CSO, India

THE ROLE OF OFFICIAL STATISTICS IN MEASUREMENT OF THE IMPACTS OF CLIMATE CHANGE: INDIAN EXPERIENCE

CLIMATE AND CLIMATE CHANGE…

- Intergovernmental Panel for Climate Change (IPCC) defines climate change as “a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or more)”

CLIMATE AND CLIMATE CHANGE…

- Climate change may results from:
- Changes in the sun's intensity or slow changes in the Earth's orbit around the sun
- Natural processes within the climate system such as changes in ocean circulation
- Human activities that change the atmosphere's composition and the land surface

IMPACT ANALYSIS

- Different models are used to find the impact of climate change on economic development, livelihood and ecosystem
- Climate models at the global and regional scale are used to study and simulate variations in climate because of the human induced perturbation

FACTS

- Climate changes have affected a diverse set of physical and biological systems across the world
- Developing countries, in particular, are more vulnerable to the impacts of climate change
- Strong correlation between emissions per capita and income per capita
- India is one of the ‘low’ GHG per capita country in the world
- Climate change has multi-sectoral impact

COUNTRY REPORT

CONDITION OF CLIMATE

- In India, climate change could represent an additional stress on ecological and socioeconomic systems
- Surface air temperatures in India are going up at the rate of 0.4°C per hundred years
- Mean winter temperatures will increase by as much as 3.2°C in the 2050s and 4.5°C by 2080s, due to Greenhouse gases
- Summer temperatures will increase by 2.2°C in the 2050s and 3.2°C in the 2080s

CONDITION OF CLIMATE…

- Effect on the monsoons
- India will experience a decline in summer rainfall by the 2050s
- Can contribute to flood disasters in the Himalayan catchment
- A trend of sea level rise of 1 cm per decade has been recorded along the Indian coast
- Climate Change will adversely affect human health in India

DATA SOURCES

Ministry/Organisation/Institution name	Type of data
Indian Metrological Department	Cyclone warning and monitoring
Central Pollution Control Board	Air pollution
Ministry of Home Affairs	Damages due to heavy rain, flood

DATA SOURCES…

Ministry/Organisation/Institution name	Type of data
Geological Survey of India	Landslide
Central Water Commission	Flood forecasting
Central Bureau of Health Intelligence	Health

DATA SOURCES…

Ministry/Organisation/Institution name	Type of data
Ministry of Agriculture	Land use, soil erosion, drought, impact of extreme temperature on production
Central Statistical Organisation	Compendium of Environment Statistics
Ministry of Environment & Forest	Environment and forest related data

A New Initiative in India…

DISASTER STATISTICS DATABASE

REQUIREMENT OF DATABASE

- While some of the hazards and disasters are manmade but most of them occurs due to change in climate
- At present no database on hazards and disaster statistics exists in India
- A database of disaster and hazards can help researchers and policy makers to analyse the impact of climate more fruitfully
- It will also help in identifying the disaster prone areas

REQUIREMENT OF DATABASE…

- Realizing the need to develop a National database on hazards and disasters, the Central Statistical Organisation (CSO) of India has taken an initiative for developing a framework for compilation of hazards and disaster statistics on regular basis
- Central Statistical Organisation (CSO) and National Institute of Disaster Management (NIDM) is currently working on this database

THE DATABASE

- In India few scientific organizations like IMD, CWC, GSI are collecting hazard/disaster data
- Different organizations are using different formats and different geographical levels
- India is currently developing a uniform framework for compilation of Hazard and Disaster Statistics to get an overall picture of hazard/disaster profile of States and Districts on annual basis
- The District has been selected as primary unit for collection of data.

THE DATABASE…

- There will be two sets of broad dataset
- **Hazard Statistics**
- **Disaster Statistics**
- **Hazard Statistics** will include:
- Rainfall:- District-wise data on heavy and scant rainfall and comparison table with normal rainfall
- Tropical Depressions:-District-wise tropical depressions in all coastal districts

THE DATABASE…

- Seismic Hazards:- Seismic data of all earthquakes with magnitude of 5 and above for districts in India and neighboring countries
- Landslides:- Data on all reported landslides
- Floods:- District-wise moderate, high and unprecedented floods, Data on reservoir levels of all major reservoirs in the country
- Drought, Hailstorms, Pest Attacks :- District-wise data on drought, hailstorm and pest attacks

THE DATABASE...

- Industrial Hazards:- Industrial/chemical accidents
- Railway Hazards and Accidents:- Data on railway deaths, injuries and damages to railway infrastructure
- Aviation Accidents:- Aviation accidents involving deaths, injuries and danger to infrastructure
- Health Hazards: Important Public health hazards

THE DATABASE…

- Disaster Statistics will contain three parts: **Damage, Relief and Reconstruction**
- **Damage** data has been classified into eight categories:

1. Lives (deaths & injuries)
2. Livestock (deaths)
3. Agriculture (Sown area affected and production loss)
4. Housing (full or partial damage)

THE DATABASE…

5. Infrastructure (damage to roads, bridges, water supply, sewerage system, irrigation, electric supply, shops/commercial buildings, other utilities)
6. Environmental Damage
7. Damage at macro-economic level
8. Health (occurrence of epidemic due to water borne and vector borne disease)

THE DATABASE…

- Data on **Relief** and **Rehabilitation** will cover the cost of relief and detailed mechanism of rehabilitation at district level

THE DATABASE…

Name of indicators/variables	Type
Rainfall, Tropical depression, Aviation accidents, Health hazards	Climate related environmental variables
Seismic hazards, landslides, Floods, Drought, Hailstorms, Pest attacks, Aviation accidents, Health hazards	Outcome of climate changes
Industrial hazards, Railway hazards	Neither climate related environmental variables nor an outcome of climate change

THE DATABASE…

- Linking these climate related variables and outcomes of climate changes to the data on damages, one can perform a detailed level analysis at the district level
- The effect on climate change on economic development, ecosystem and human lives can be analysed for different environmental zones using the detailed level data at district level

The challenge before us is not only a large one, it is also one in which every year of delay implies a commitment to greater climate change in the future……

Climate Change and Water

How Water Accounts can Help our Understanding

Presented by Peter Harper
Deputy Australian Statistician
Population, Labour, Industry and Environment Statistics Group
Australian Bureau of Statistics

Conference on Climate Change and Official Statistics
Oslo, Norway, April 2008

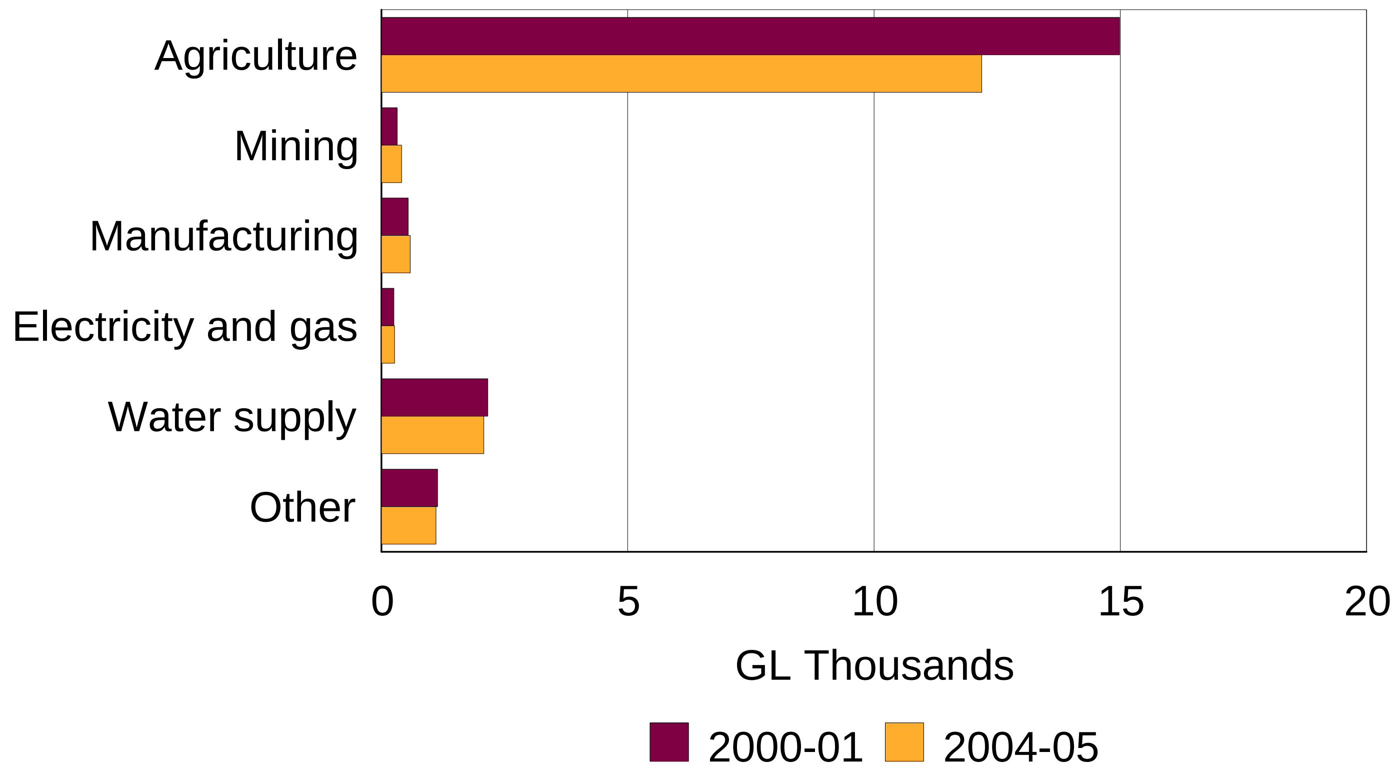
Session Outline

- Introduction
- Water use by industry
- Household water use
- Regional water accounts
- Monetary water accounts

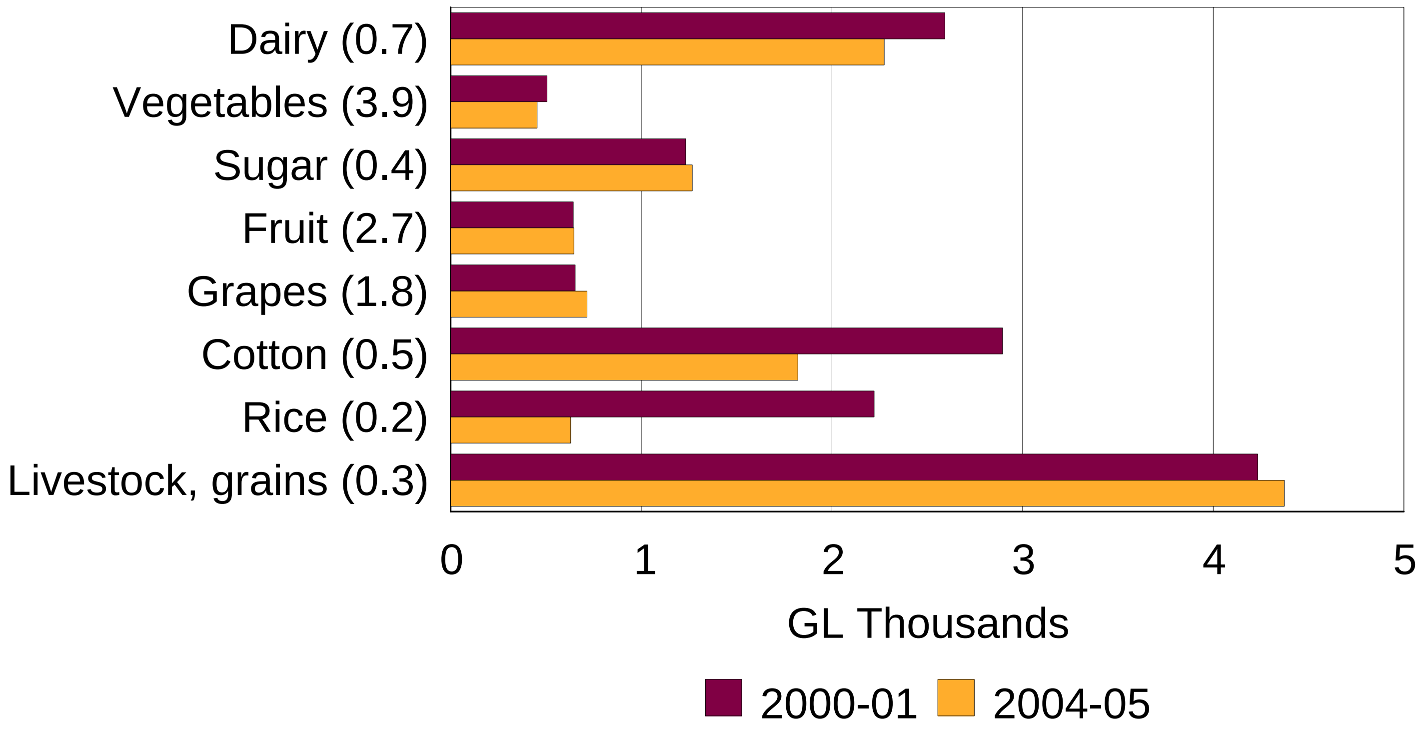
Introduction

- Australia has produced 3 sets of water accounts
  - Latest in respect of 2004-05 (released in November 2006)
  - Accompanied by experimental monetary account
  - Currently produced 4-yearly
    - Annual measures of agricultural water use
- Based on SEEWA
- Helps to analyse impact of climate change, which could impact on the abundance, distribution and availability of water across the continent

Water use by industry



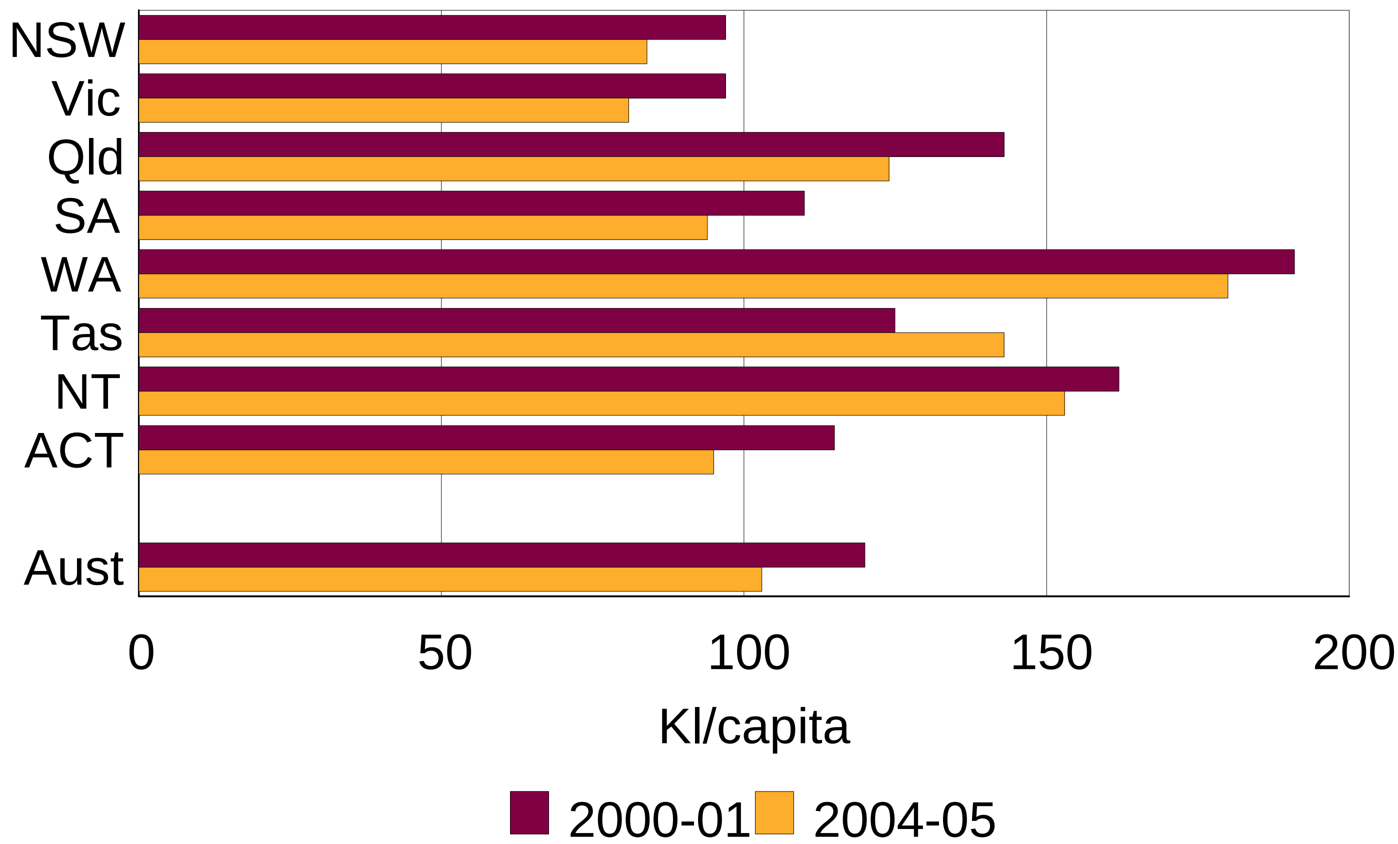
Agriculture



Other industries

- Mining
  - Mining boom ➔ increased water usage
- Manufacturing
- Electricity and Gas
  - Hydro: water availability impacted by weather and climate
- Water supply
  - Distributed vs re-use

Households


NSW
Vic
Qld
SA
WA
Tas
NT
ACT
Aust
0
50
100
150
200
Kl/capita
2000-01
2004-05

Regional water accounts

- Climate change could have different impacts in different parts of Australia
- Also, some regions are more dependent on water than others
- Regional water accounts can help our understanding
- Flexible geographies are important
  - Geospatial presentations
- In Australia, the Murray-Darling Basin is particularly important
  - The ABS will shortly release a detailed study of this region

Australian Bureau of Statistics

Monetary water accounts

- Combining physical information with relevant monetary information creates a powerful analytical tool
- Enhances understanding of the value of water and water-related assets
- Enables responses to changing water prices and trading policies to be studied
- Can help in understanding effectiveness of institutional arrangements
- Can help shed light on cost/benefit analysis of alternative water supplies if ‘traditional’ supplies are impacted by climate change

Conference on Climate Change and Official Statistics

Oslo, Norway, 14-16 April 2008

Impacts of climate change in Europe

André Jol

European Environment Agency

Above +2ºC impacts will be large

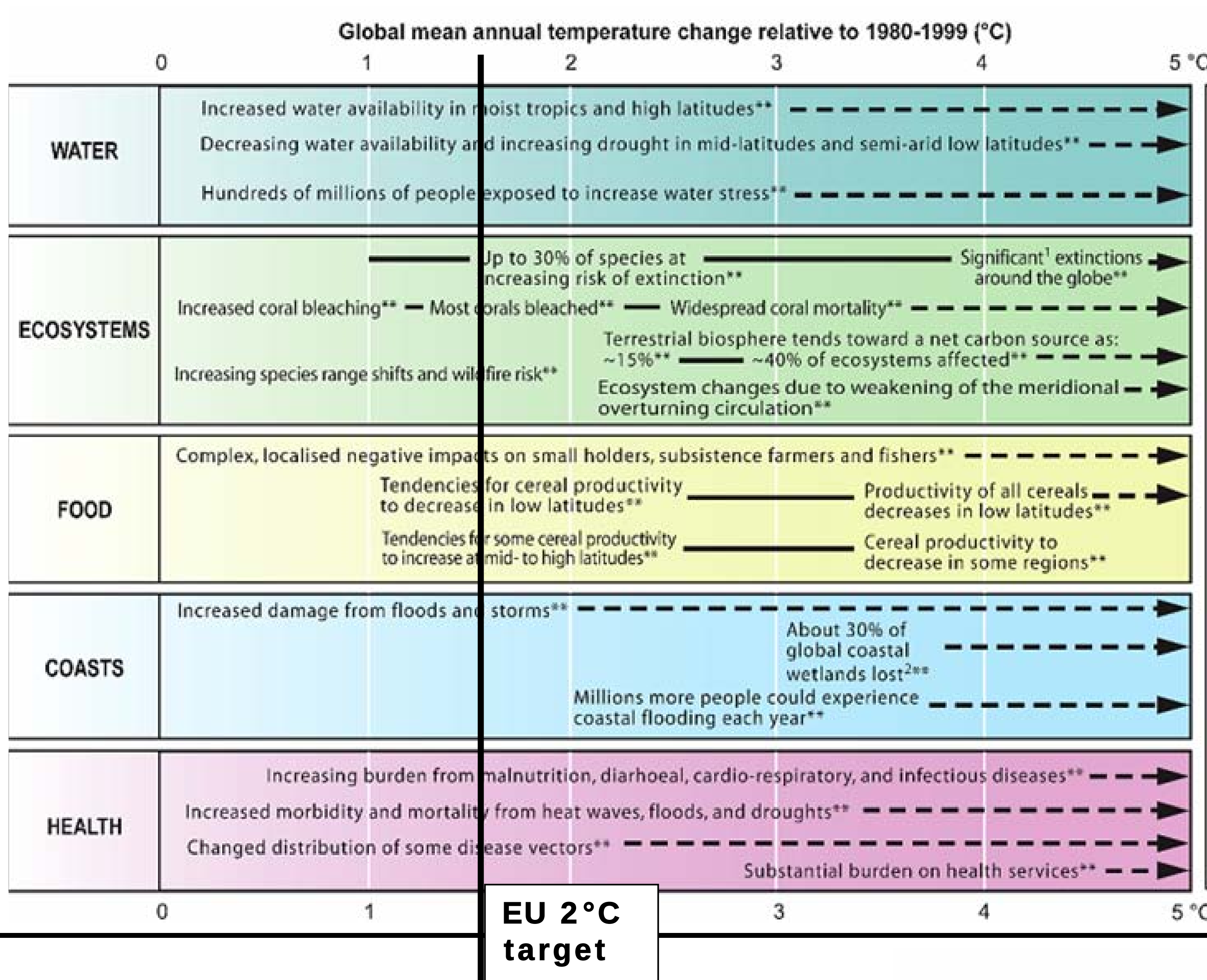
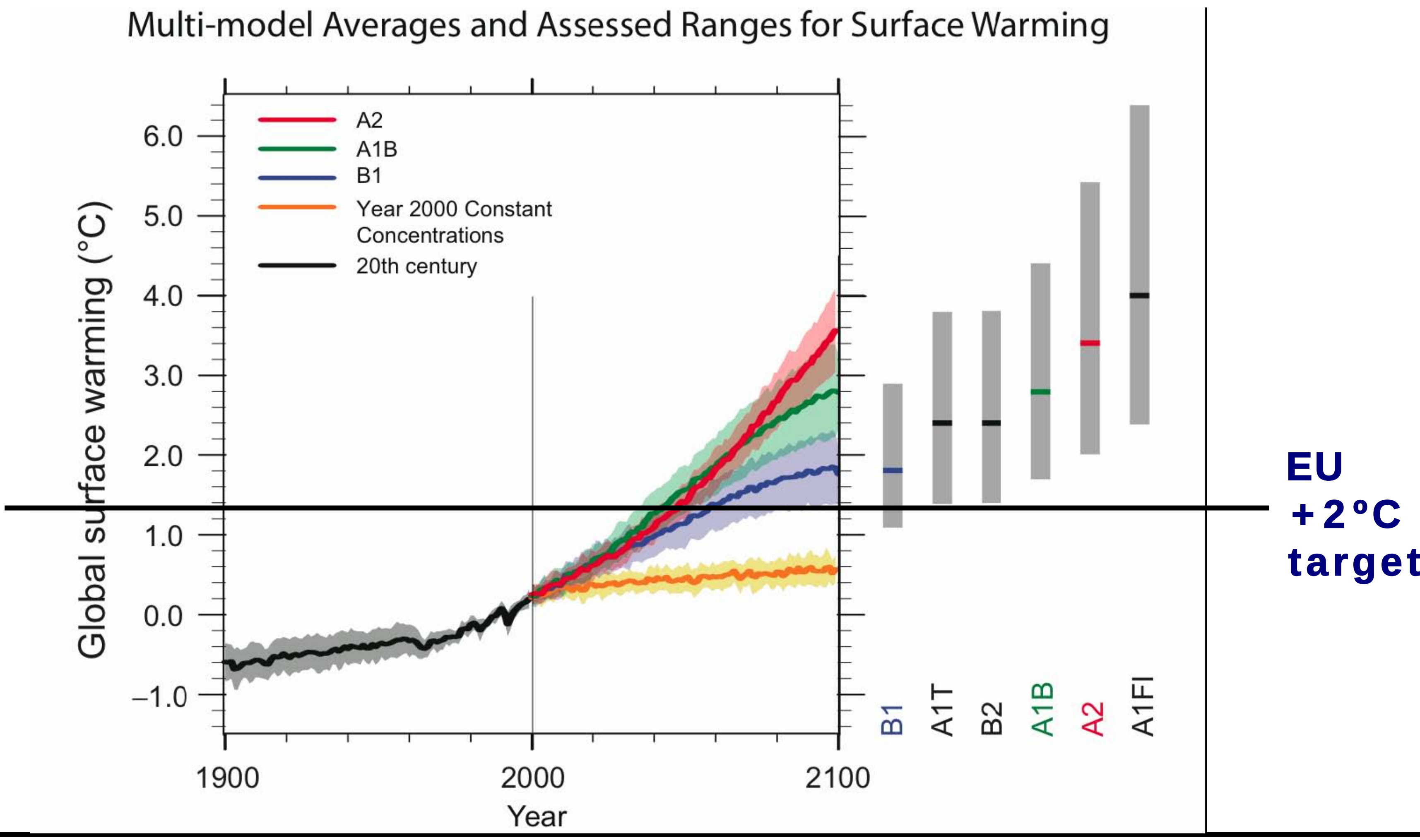


Figure 3: Key impacts as a function of increasing global average temperature change[1]

[1]Above 1980-1999 levels. To express the change relative to the period 1850-1899, IPCC WG II adds 0.5 degrees C

European Environment Agency

Substantial global GHG emission reduction is needed as well as adaptation



Source: IPCC fourth assessment, 2007 (full uncertainty range for temperature increase is 1.1-6.4°C)

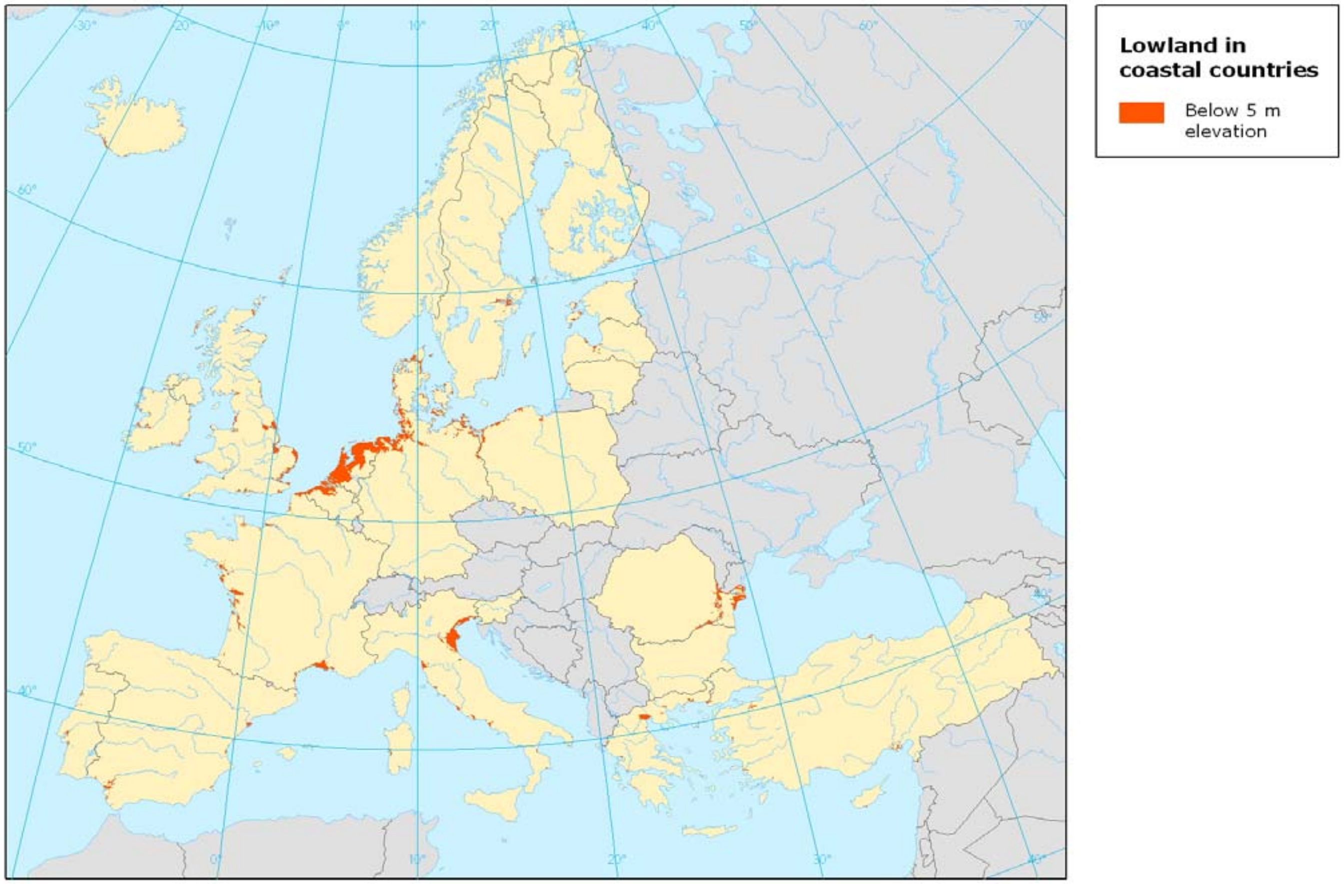
European Environment Agency

Why is adaptation important ?

- Climate change cannot be totally avoided
- Anticipatory adaptation can be more effective and less costly than “retrofitting” or “emergency adaptation”
- Climate change may be more rapid and pronounced than currently known
- Immediate benefits from adaptation to current climate variability and extreme events
- Avoid maladaptive policies and practices

Coastal zones

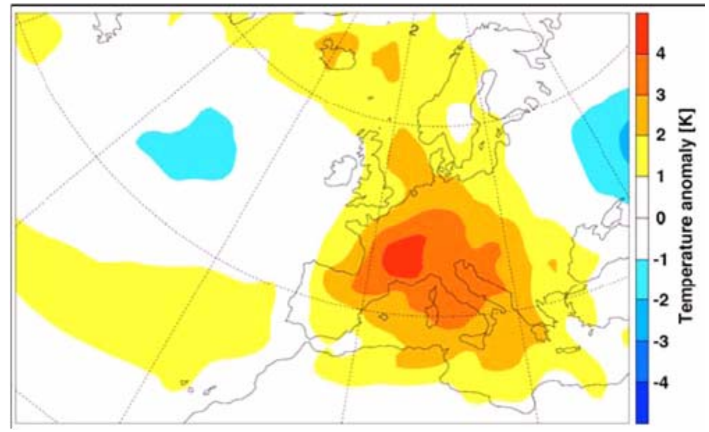
- Sea level is projected to rise for centuries (0.2-0.6 m by 2100)
- Future increase in storm frequency and intensity (uncertainties)
- 9% of all European coastal zones is below 5 m elevation potentially vulnerable to sea level rise and related inundations and the exposed population in the main coastal European cities is expected to increase
- Coastal zone ecosystems are threatened

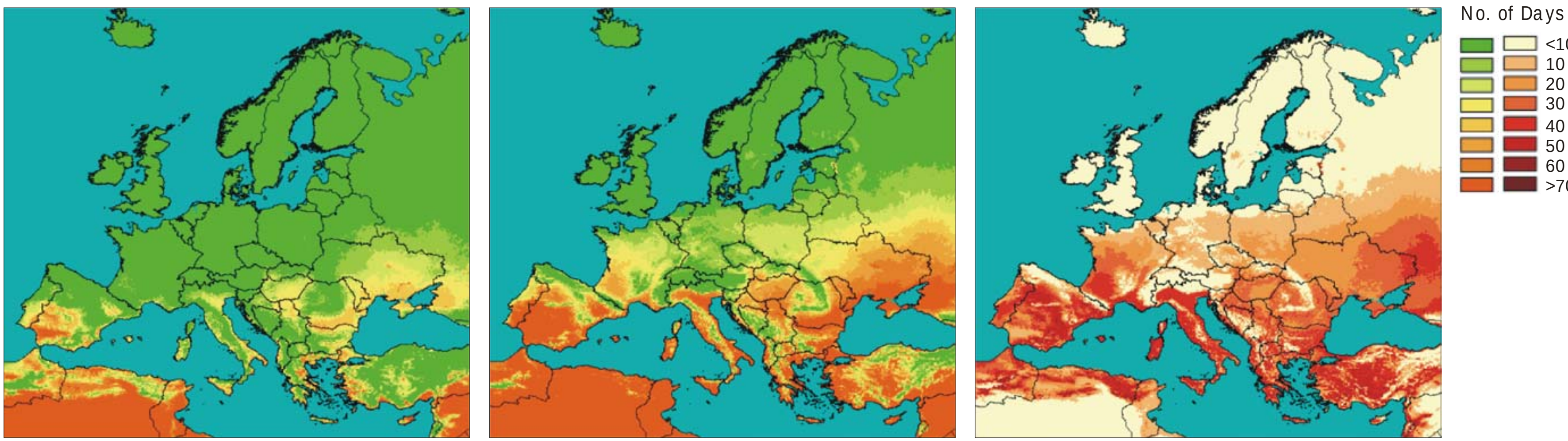


Source: IPCC, 2007; EEA, 2006

European temperature extremes

- Cold extremes are less frequent, the frequency of hot days has almost tripled between 1880 and 2005 and the number of warm extremes doubled
- Heat waves and droughts will increase in frequency, intensity and duration, the number of cold and frost extremes will further decrease
- By 2050 every other summer could be as hot as 2003





Tropical Nights, average 1961-1990 for June, July and August

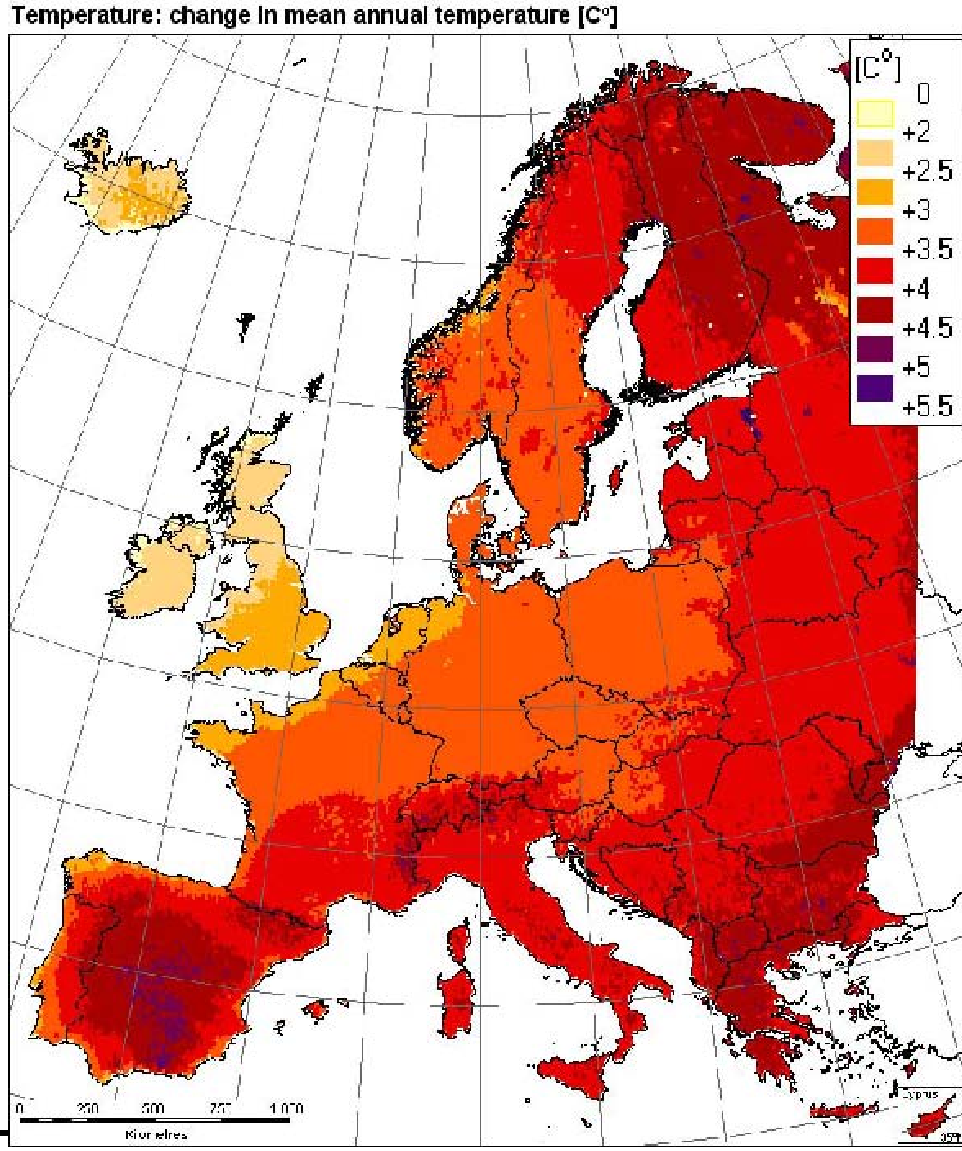
Tropical Nights, average 2071-2100 for June, July and August

Change in Days of Tropical Nights from Control To Scenario Period, for June, July and August

6 Sources: KNMI, ENSEMBLES project 2008; Schär, 2004

European Environment Agency

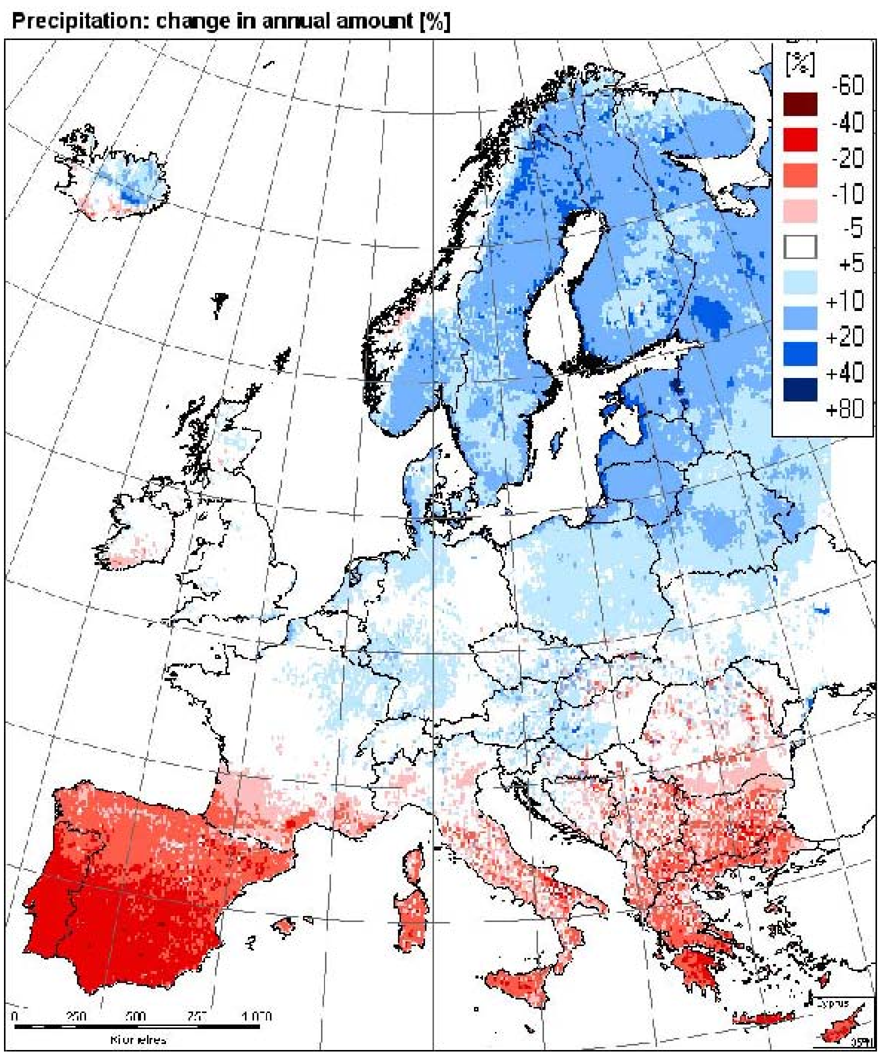
European temperature projected to increase most in north and south (Mediterranean)

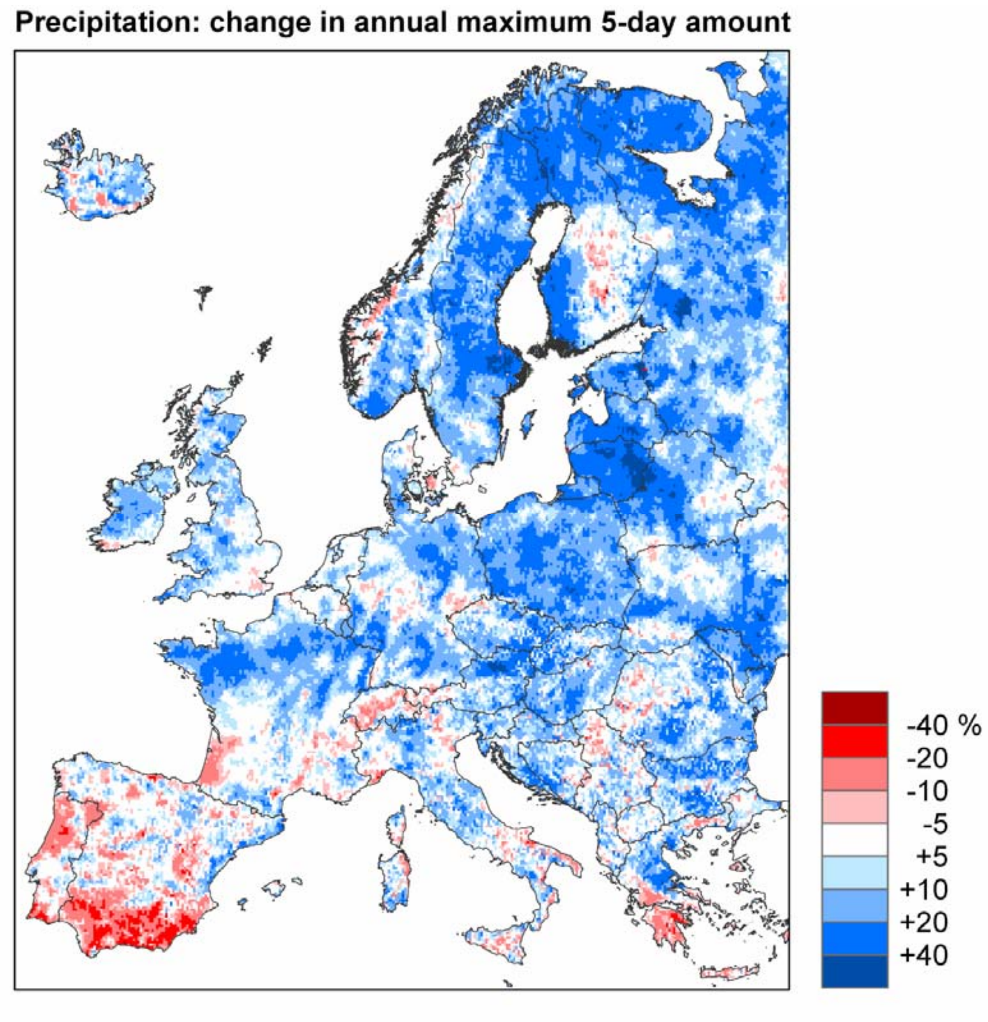


Source: PESETA project, PRUDENCE; IPCC SRES A2 high emission scenario (change mean annual temperature 2071-2100 relative to 1961-1990)

European Environment Agency

Precipitation projected to increase in northern, decrease in southern Europe; more frequent droughts and floods likely



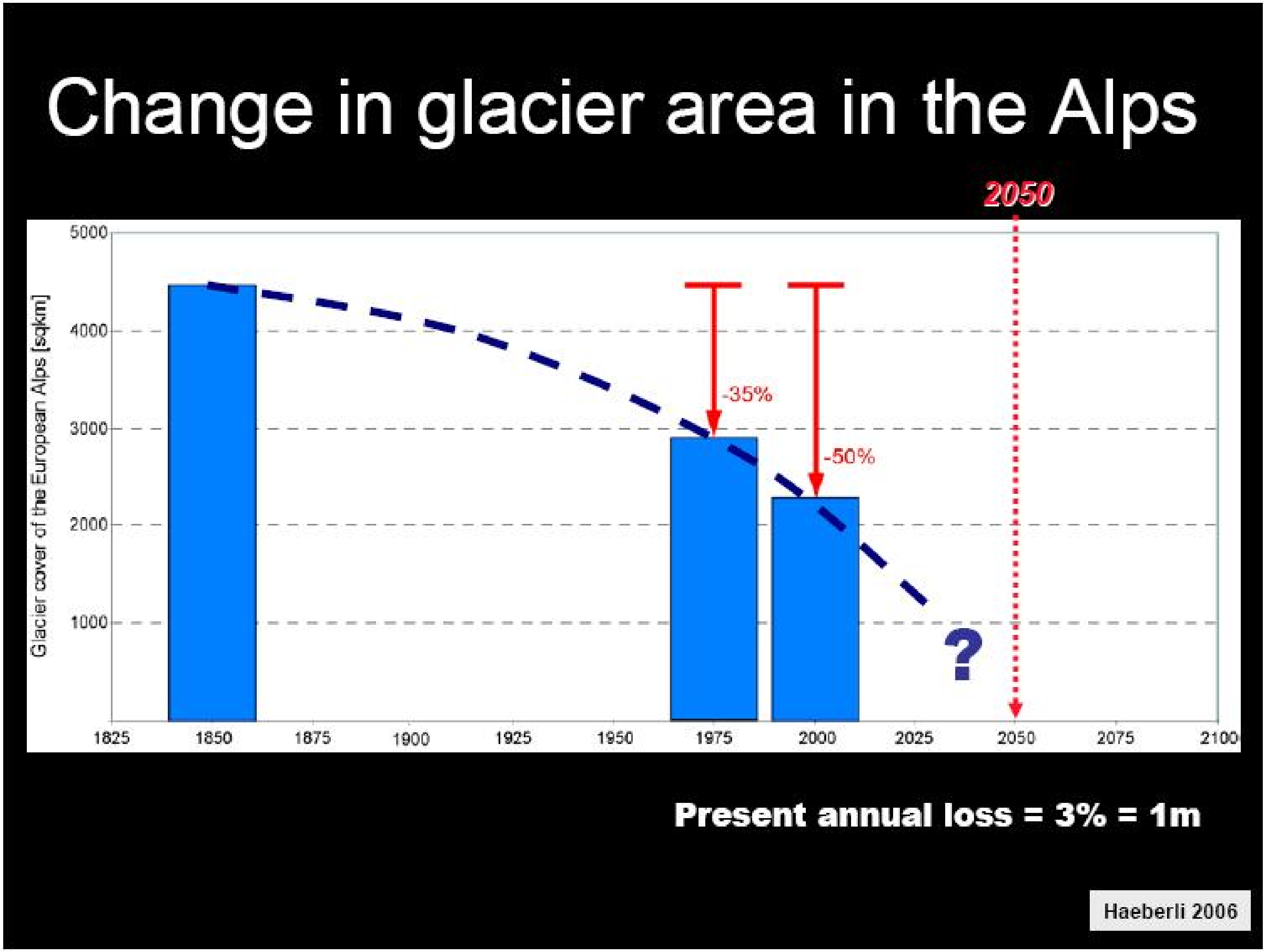


Source: PESETA project, PRUDENCE; IPCC SRES A2 high emission scenario (change 2071-2100 relative to 1961-1990)

8

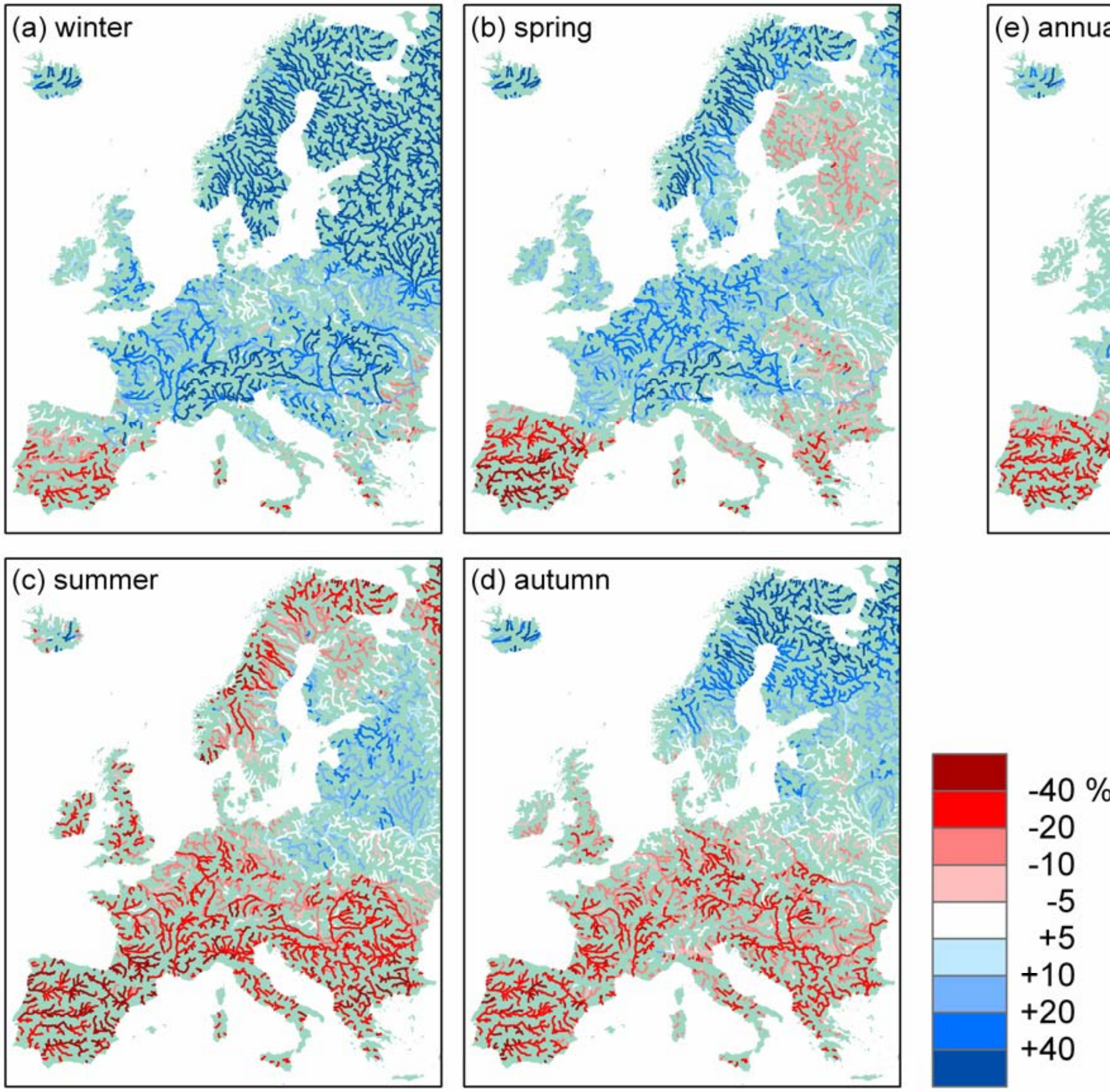
European Environment Agency

Glaciers lost 50% of mass between 1850 and 2000, projected to further reduce



River flow changes

- Annual river flow is projected to decrease in southern Europe and increase in northern Europe
- Summer flows will decrease and winter/spring flows will increase in most parts of Europe

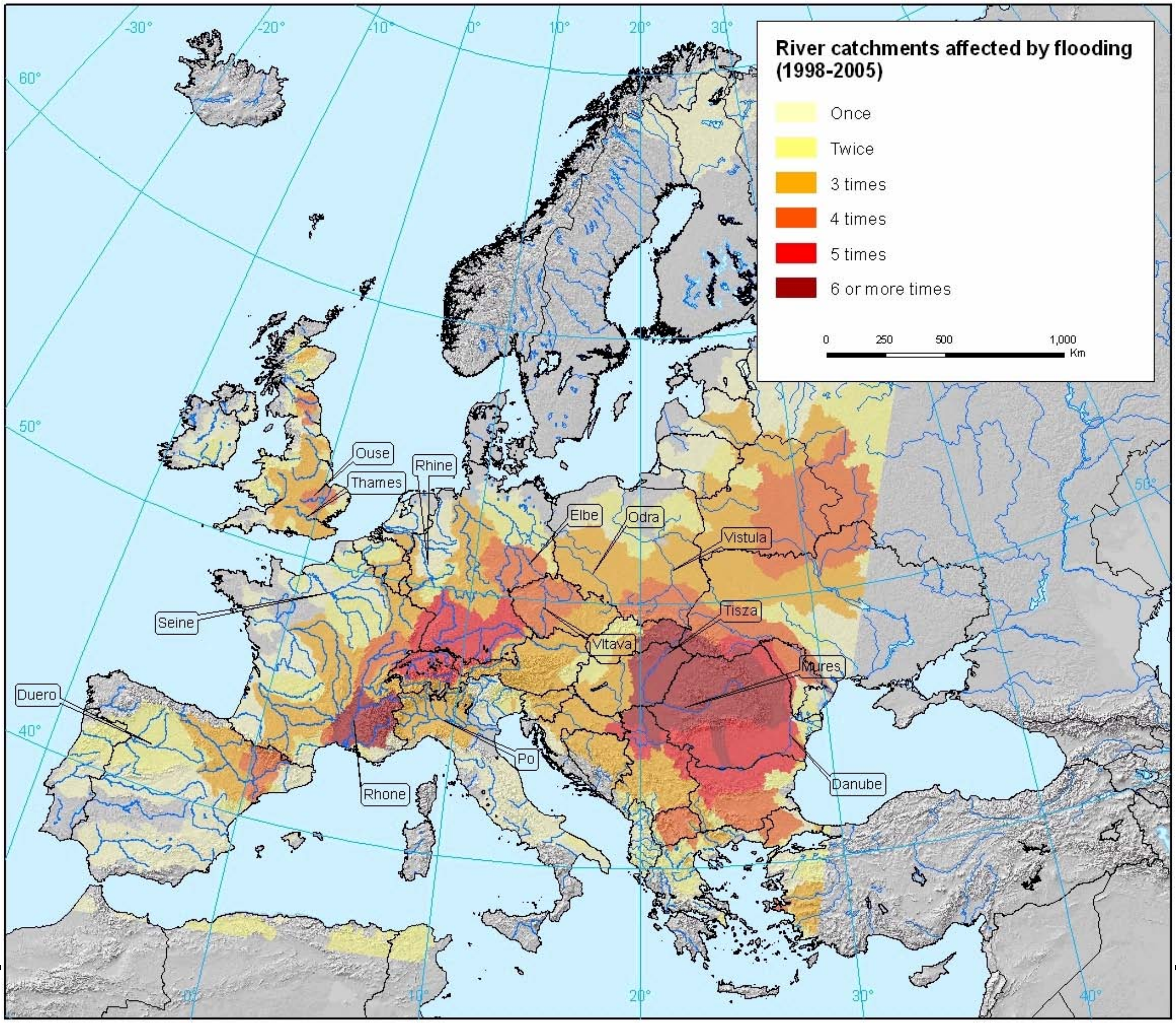


Source: JRC, 2008

Agency

River flooding events 1998-2005

- About 100 (river) floods: more than 700 fatalities, a million people affected and 25 billion EUR in insured economic losses



3

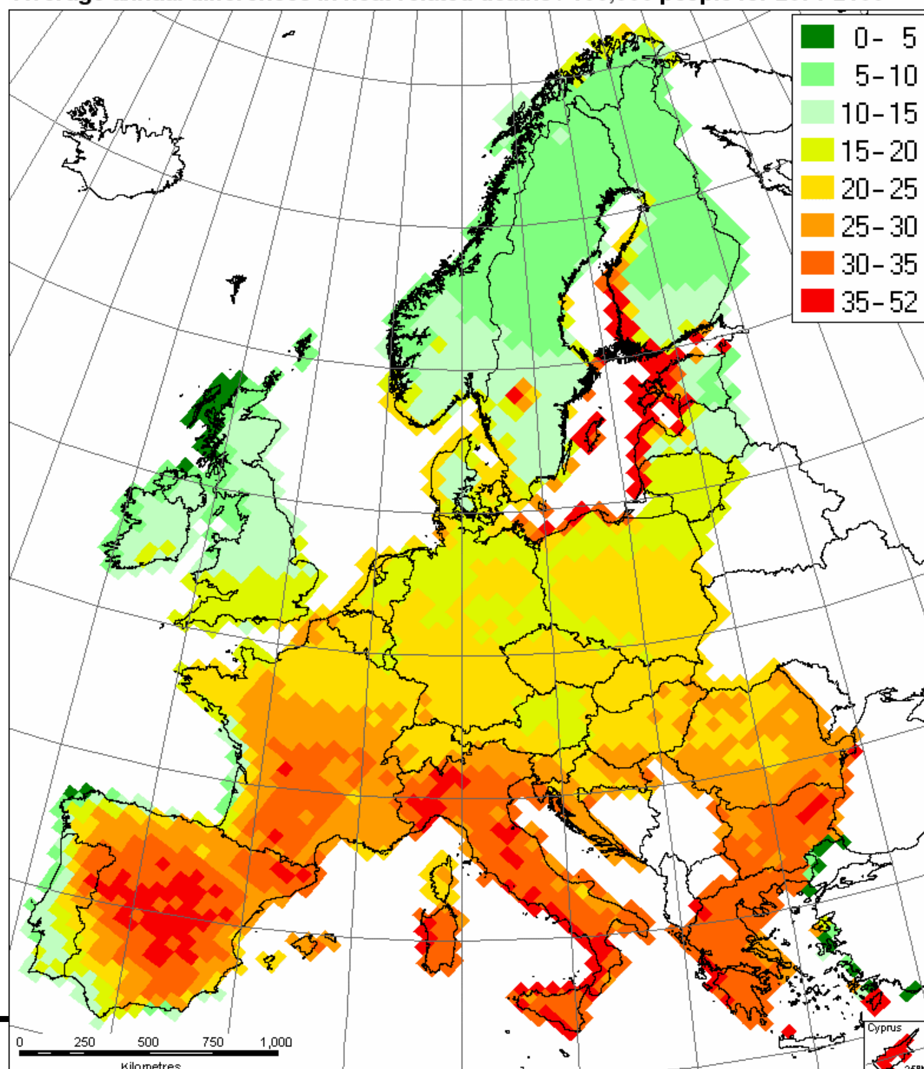
Data-source: EEA, 2006

European Environment Agency

Projected increase in heat-related deaths in Southern Europe

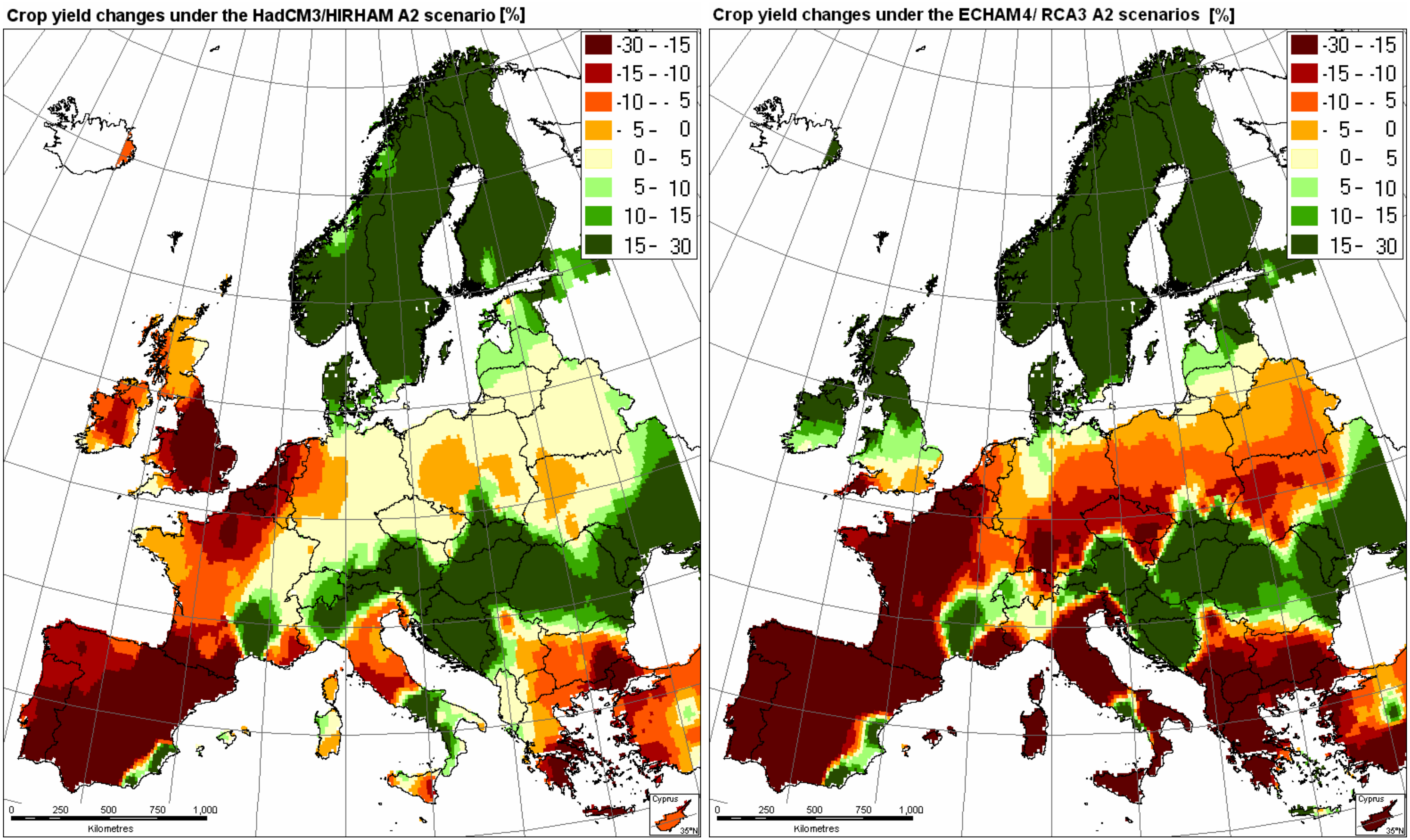
- Hot summer of 2003 resulted in more than 70,000 excess deaths (12 countries)
- 86,000 excess deaths per year are projected in the EU at a global mean temperature increase of 3°C (A2 scenario) without adaptation

Average annual differences in heat-related deaths / 100,000 people for 2071-2100



Source: PESETA project, PRUDENCE; IPCC SRES A2 high emission scenario (change mean 2071-2100 relative to 1961-1990)

Projected crop yield decrease in Southern Europe, increase in Northern Europe (2 models)



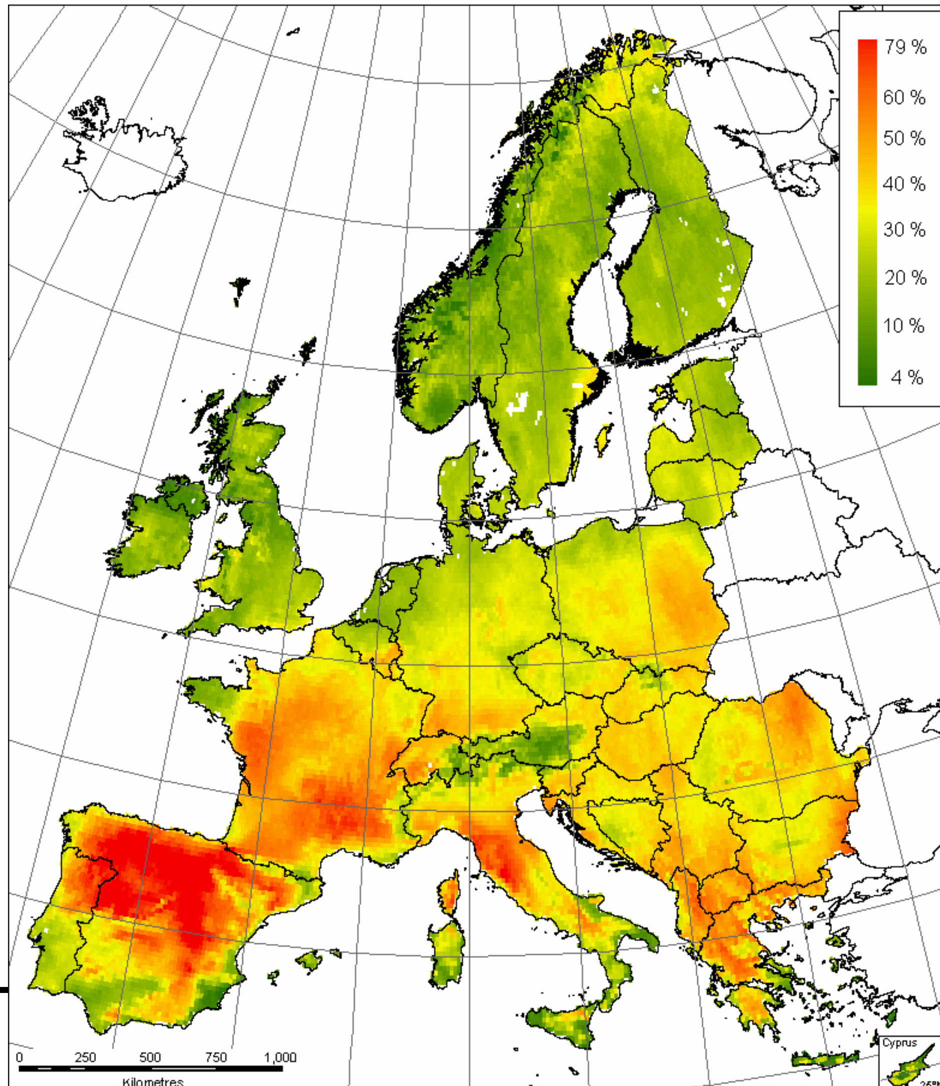
Source: PESETA project, PRUDENCE; IPCC SRES A2 high emission scenario (change mean 2071-2100 relative to 1961-1990)

European Environment Agency

Projected local extinction of plants in Southern Europe

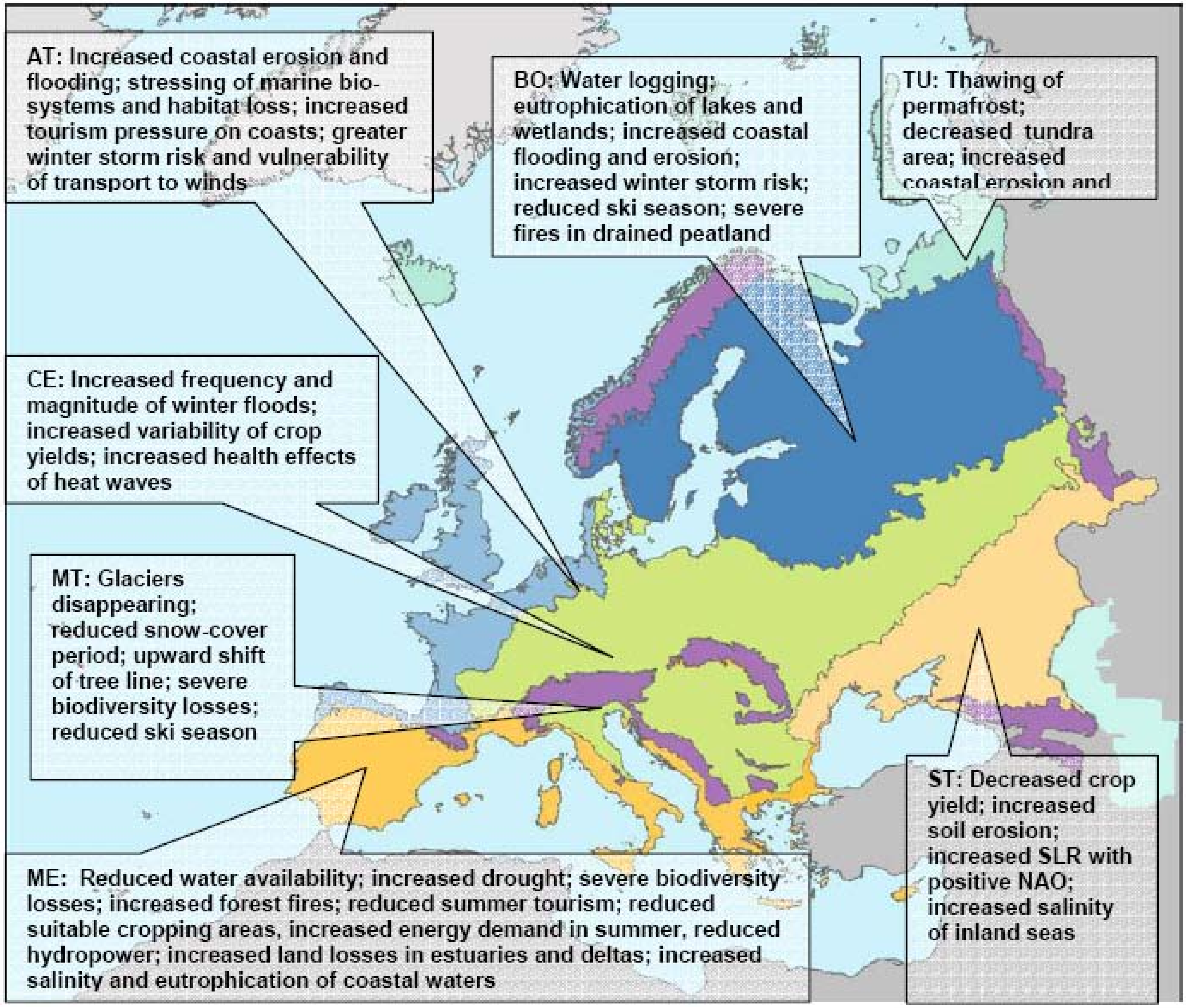
- By the late 21st Century, distributions of European plant species are projected to have shifted several hundred kilometres to the north and 60% of mountain plant species may face extinction. The rate of change will exceed the ability of many species to adapt.

Modelled local extinction in plant communities under the A2 HadCM3 climate model by 2080 [%]



Source: ATEAM, 2004, IPCC A2 scenario

Key European vulnerable regions and sectors



 Source: IPCC, 2007; EEA, 2004

European Environment Agency

Examples of national assessments

- Finland: FINADAPT (Assessing the adaptive capacity of the Finnish environment and society under a changing climate)
- Germany: KomPass (Competence Centre on Climate Change Impacts and Adaptation)
- Hungary: VAHAVA Changing (VÁltozás) Impact (HAtás) Response (VÁlaszadás)
- Netherlands: CcSP (Climate Changes Spatial Planning)
- Portugal: SIAM (Scenarios, Impacts and Adaptation Measures)
- Spain: ECCE (Assessment of the Preliminary Impacts in Spain due to Climate Change)
- Sweden: SWECLIM (Swedish Regional Climate Modelling Programme)
- UK: UKCIP (Climate Impact Programme)
- All countries: communications to UNFCCC

Current national adaptation plans and measures

- Preparation of national adaptation strategies: **Denmark**, **Germany, Finland, France, Hungary, Netherlands, Portugal, Slovakia, Spain, UK,, etc**
- Sectoral actions mainly in areas with a long tradition of dealing with climate extremes such as **flood defence, water scarcity and droughts (**focus of EEA 2007 study)
- **Droughts**: new water savings standards; recycling; new infrastructure; desalinisation plants; economic instruments
- **Floods**: emergency responses; improved forecasting; Self-protection and flood awareness; spatial planning and land management; hard and soft engineering

European Adaptation Challenges

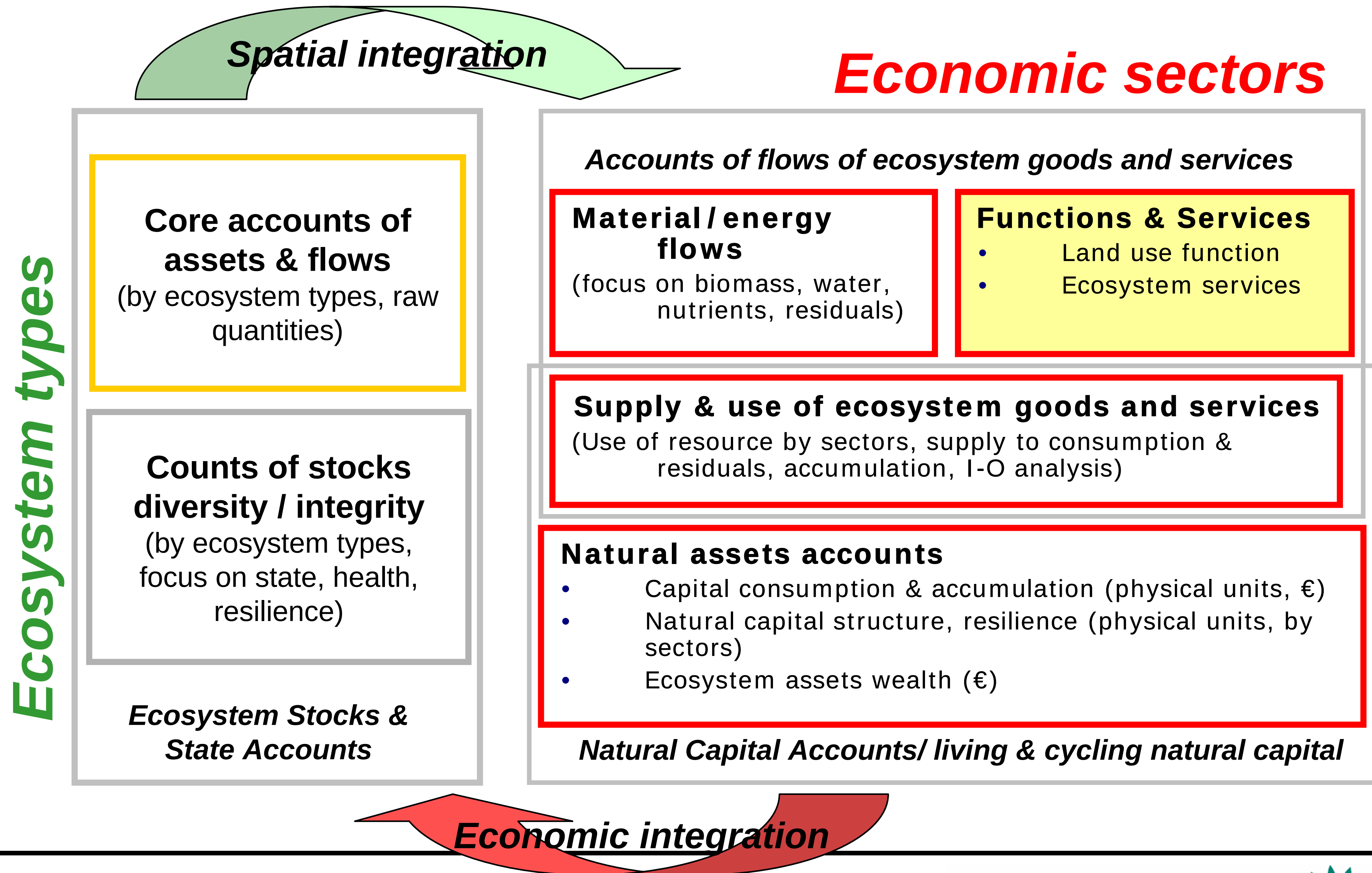
- Climate-proof EU policies and Directives (Agriculture, Industry, Energy, Health, Water, Marine, Ecosystems/Biodiversity, Forestry)
- Integrate adaptation into EU's funding programmes (Structural, Cohesion and Solidarity funds, Agriculture and Rural Development funds)
- Consider new policies, e.g. spatial planning as an integration tool
- Integrate adaptation in EU external relations (developing countries)
- **Enhancing the knowledge base, e.g. regarding regional scale and information on costs**
- Involvement of civil society, business sector organisations and enhanced information exchange
- Exploit opportunities for innovative adaptation technologies

Commission Green Paper, consultation in 2007
White Paper with concrete proposals expected end of 2008

Data and information needs

- Projections of climate change at detailed level (from downscaled climate change models)
- Frequency and intensity of extreme weather events
- Seasonal data (e.g. in agriculture; forestry; water accounts) and projections
- Data across scales, e.g. water balances at river basin level, ecosystem functional units and services
- Economic valuation approaches for accounting ecosystem services in physical and monetary terms
- Information on practical adaptation measures and costs of adaptation

Can ecosystem accounting be used for climate change vulnerability assessments?



Ecosystem Accounting Framework

- **Stocks & flows**
  - Spatial systems:
    - **land cover** (units, zones, landscape types)
    - river reaches, rivers, catchments
    - coastal systems
  - Biomass, Productivity (NPP/NEP), Carbon Storage
  - Nutrients (N,P)
  - Water
  - Species
  - Other...
- System interactions
- Services
- Values

➔ Basic ecosystem stock flows accounts

Ecosystem Accounting Framework

- Stocks & flows
- **System interactions**, integrity & health
  - Spatial interactions (ecotones, distributions, composition / scales)
  - Components interactions
    - Spatial & temporal interactions (water stress, species dynamics...)
    - Bio-chemical-physical cycles
  - Human interactions
    - Re-structuring, over-harvesting/over-extraction, deposition of residuals and force-feeding, introduction of species – use of land and the natural capital
  - Health – Ecosystem Distress Syndrome
- Services
- Values

Ecosystem Accounting framework

- Stocks & flows
- System interactions
- **Ecosystem Services**
  - Input/output to/from production, MEFA
  - Extracted or harvested products
  - Final services to population (non-market, collective or individual)
- Values

European Environment Agency

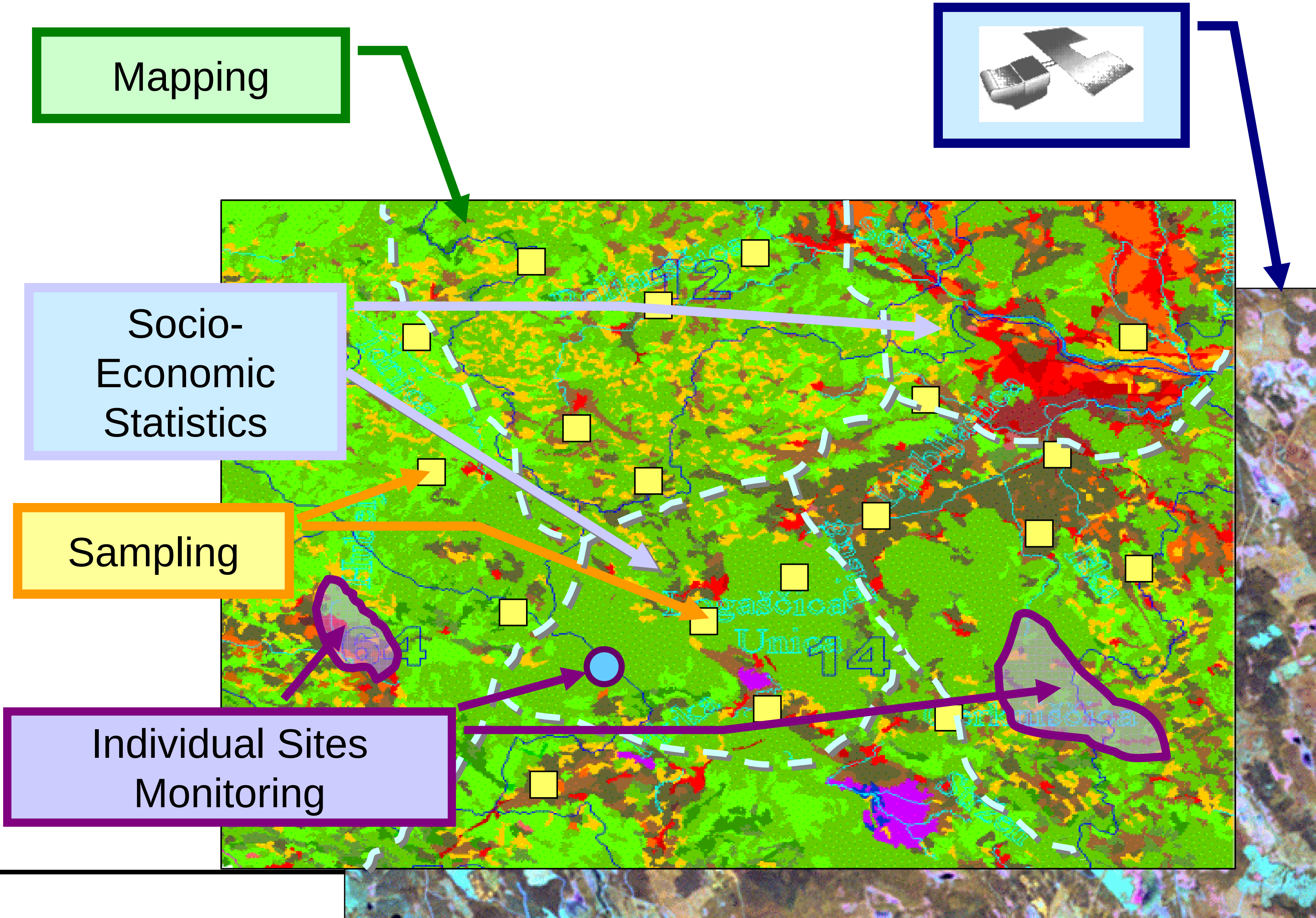
Ecosystem Accounting framework

- Stocks & flows
- System interactions
- Services
- **Values**
  - Primary goods and ecosystem based market services
  - End use, collective & individual non market services & IDP
  - Additional maintenance/restoration costs & FCGS
  - Inclusive Wealth

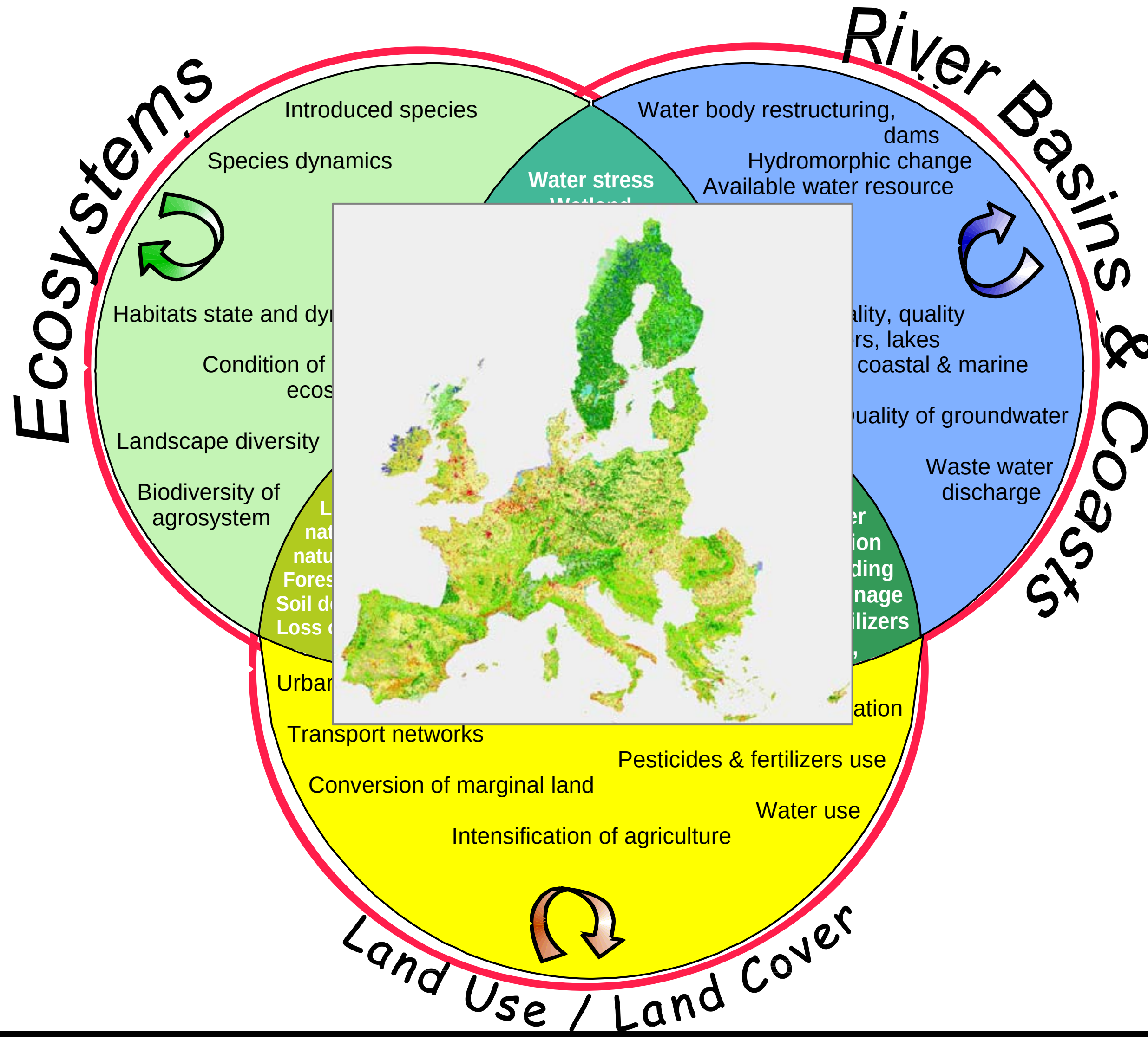
Integration...

- Thematic integration:
  - environmental themes (interactions, ecosystem resilience)
  - environment-economy (ecosystem goods & services, natural capital)
  - environment-human health
- Spatial integration:
  - analytical units
  - spatial distribution, neighbourhoods
  - nested scales, natural systems, decision levels
- Time integration:
  - change, time series,
  - infra-annual variability
  - now-casting, modelling
- Data assimilation:
  - heterogeneous monitoring data and statistics
  - stratification(s), fuzzy logic and probabilities
- Reporting:
  - reporting units (administrative, hydrological, bio-geographical, zonal (e.g. coasts, rural landscape...)
  - current policies vs. trends assessment...

Spatial Integration of Environmental & Socio-Economic Data Collection



Platform for Integrated Spatial Assessment



European Environment Agency

Summary and conclusions

- For **climate change impacts, vulnerability and adaptation** strategies and policies are emerging and **new data** with more details in time and space are needed
- This requires a **joint effort** by environmental agencies and statistical institutes as well as businesses, and the meteorological and research community, at national, European and global level
- EEA works together with Eurostat and member countries to **strengthen the links between environment and economic statistics** (ecosystem accounting)
- **Report on climate change impact indicators due in Sep 2008**, jointly with European Commission Joint Research Centre (JRC) and WHO Europe
- Development of a **clearinghouse** on climate change impacts, vulnerability and adaptation in collaboration with the European Commission (DG Environment)

MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Measure of the impacts of, vulnerability and adaptation to climate change in South America

José A. Marengo
Instituto Nacional de Pesquisas Espaciais – INPE
marengo@cptec.inpe.br

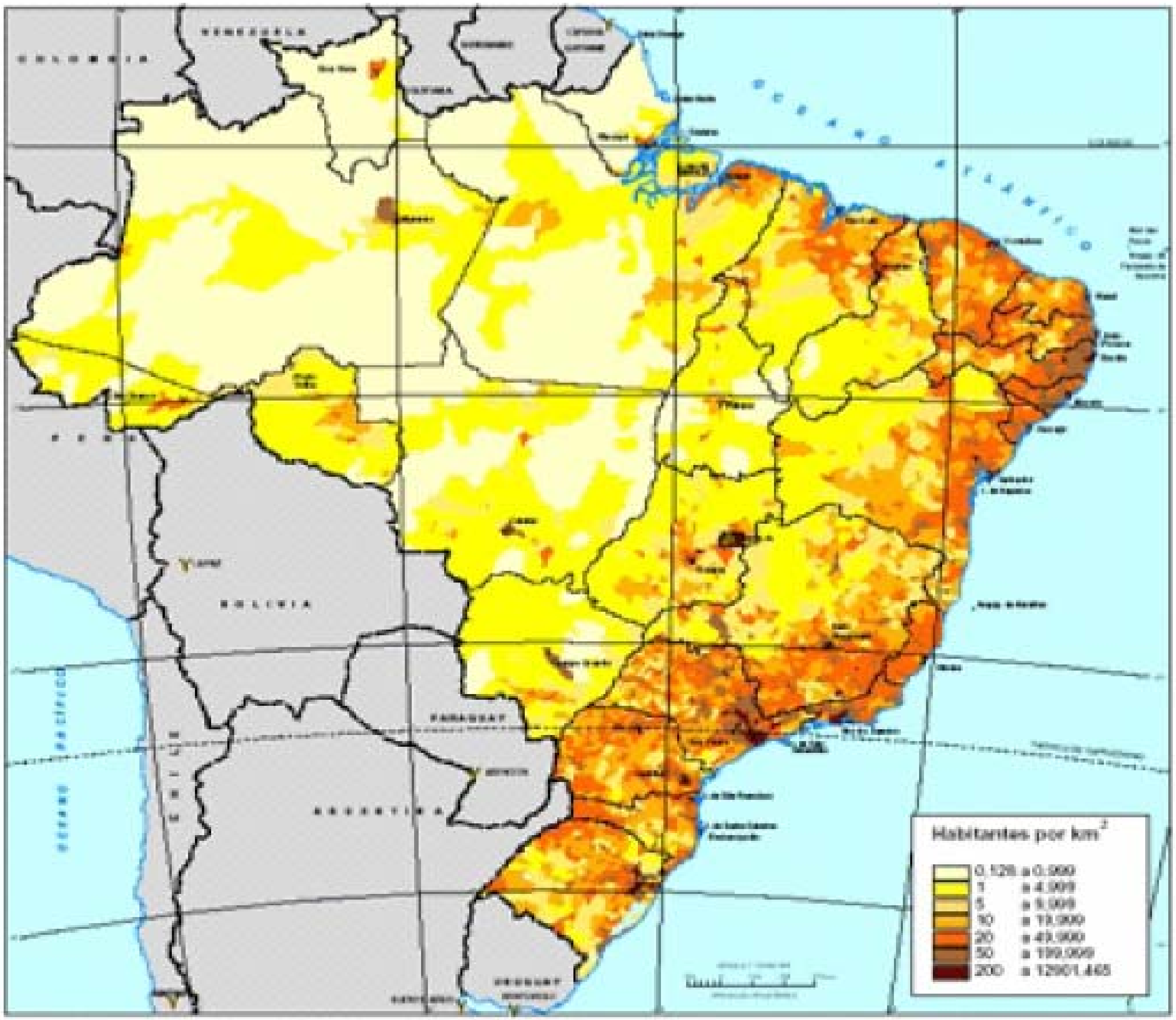
Conference on Climate Change and Official Statistics

Oslo, Norway, 14-16 April 2008

Contents…

- Climate change in Brazil, impacts, vulnerability
- Future climate change scenarios and the Amazon, results from downscaling experiments in Brazil
- Hots spots for climate change: Amazonia (biodiversity and social), Northeast Brazil (social) southern Brazil (agriculture and hydroelectric generation)
- Adaptation and mitigation alternatives: Deforestation, environmental services, biofuel

Population density in Brazil (IBGE 2000)



Fonte: IBGE, 2000a.

TABLE 1

Human development index

UNDP (2007)

HDI rank [a]	Human development index (HDI) value 2005	Life expectancy at birth (years) 2005	Adult literacy rate (% aged 15 and above) 1995-2005[b]	Combined gross enrolment ratio for primary, secondary and tertiary education (%) 2005	GDP per capita (PPP US$) 2005	Life expectancy index	Education index	GDP index	GDP per capita (PPP US$) rank minus HDI rank [c]
HIGH HUMAN DEVELOPMENT									
70 Brazil	0.800	71.7	88.6	87.5 [h]	8,402	0.779	0.883	0.740	-3

TABLE 2

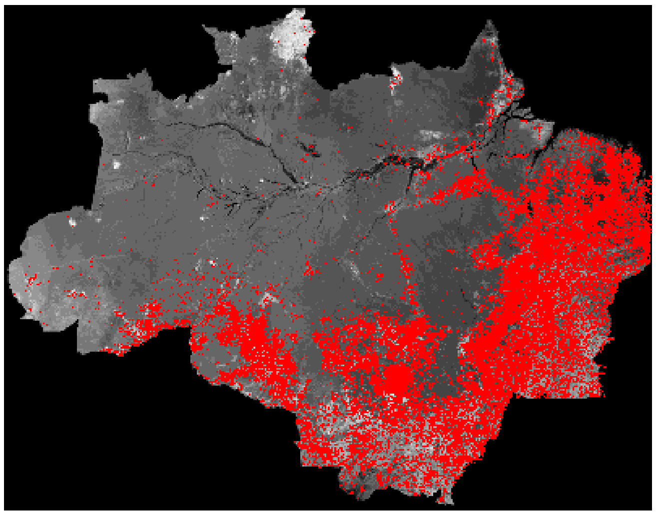
Monitoring human development: enlarging people's choices...

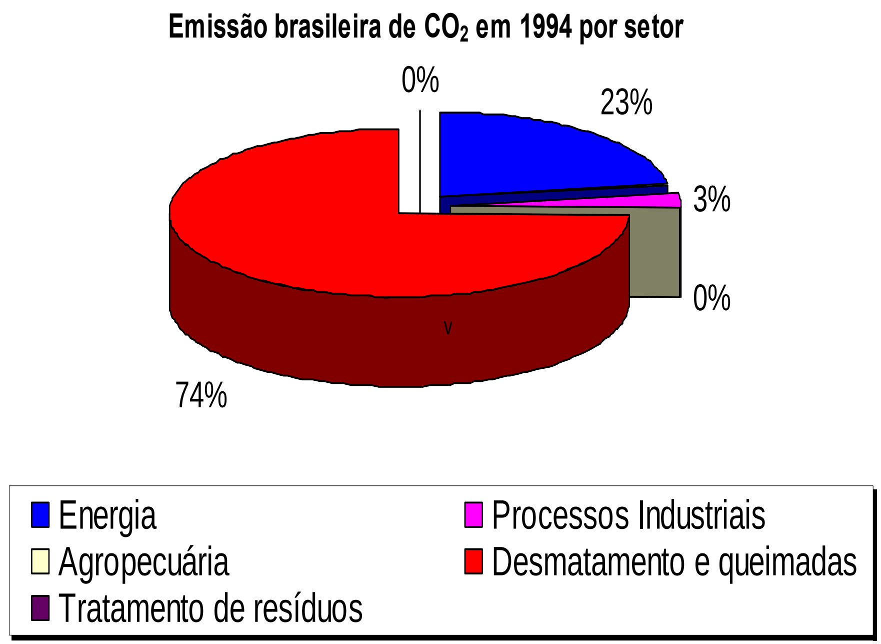
Human development index trends

HDI rank	1975	1980	1985	1990	1995	2000	2005
70 Brazil	0.649	0.685	0.700	0.723	0.753	0.789	0.800

¾ of Brazilian GHG emissions come from Deforestation

MCT (2004)

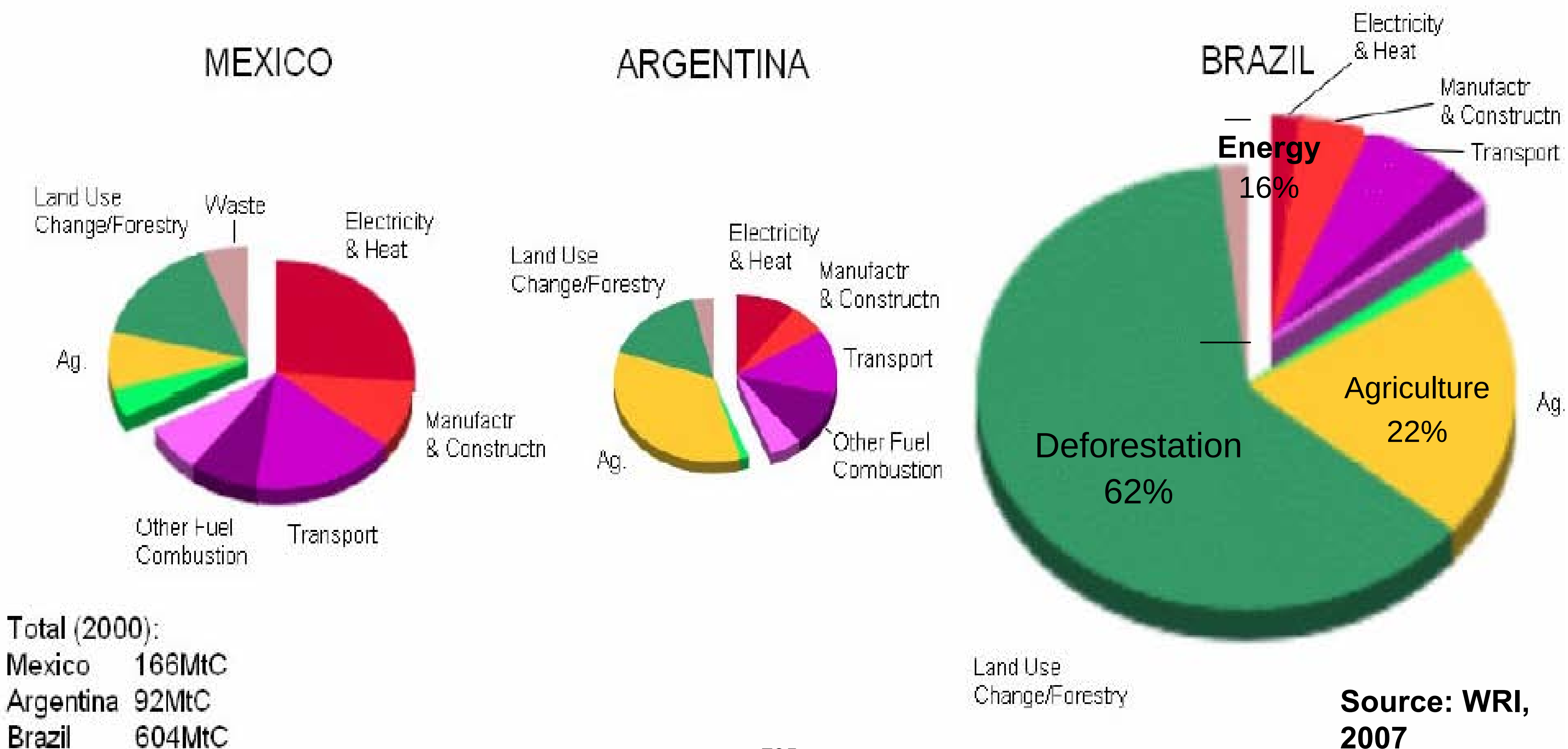




Brazilian emissions of CO_2 (per capita):

- 0,5 ton C/year from fossil origin
- 1,5 ton C/year from mean deforestation
- 1,0 ton C/year from 2007 deforestation

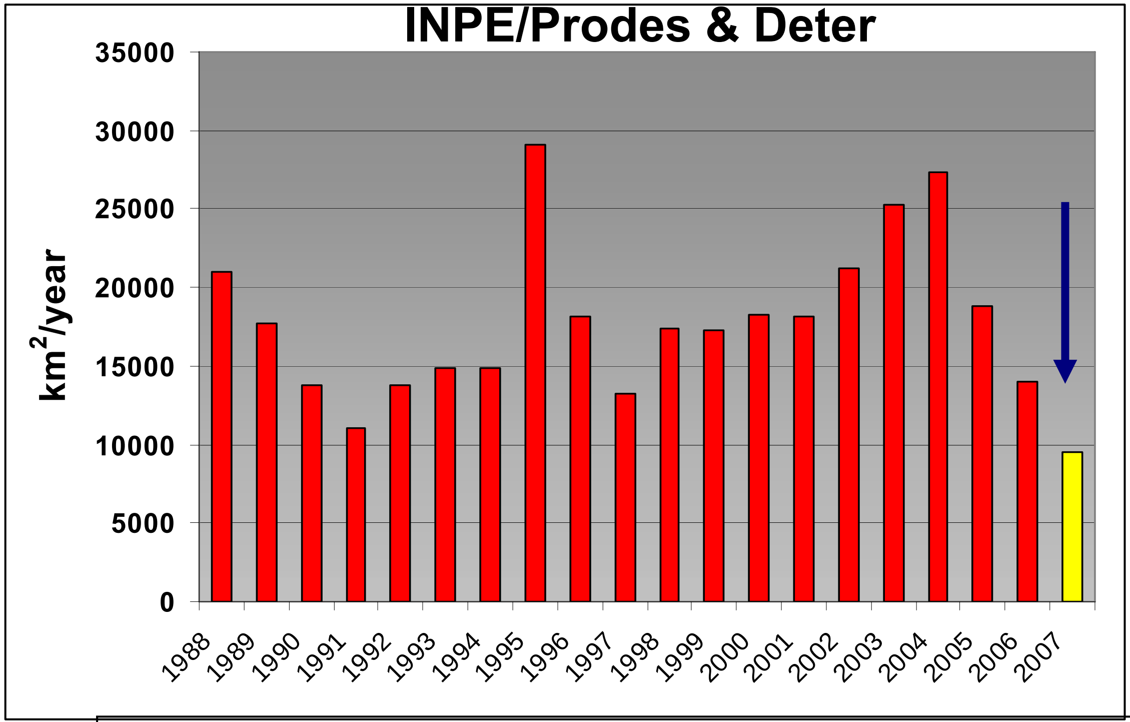
Importance of the energy sector in the emissions of Greenhouse Gases in Latin America

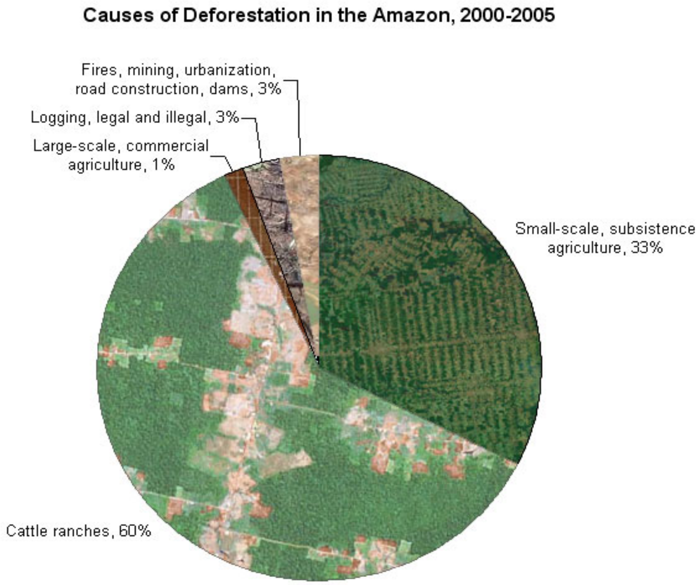


Source: WRI, 2007

Avoided emissions from deforestation reductions make more sense

- 2004: 27.361 km² deforested in Brazilian Amazon
- 2005 – 2007: ~60% reduction in deforestation
- 2007-08 goin up again



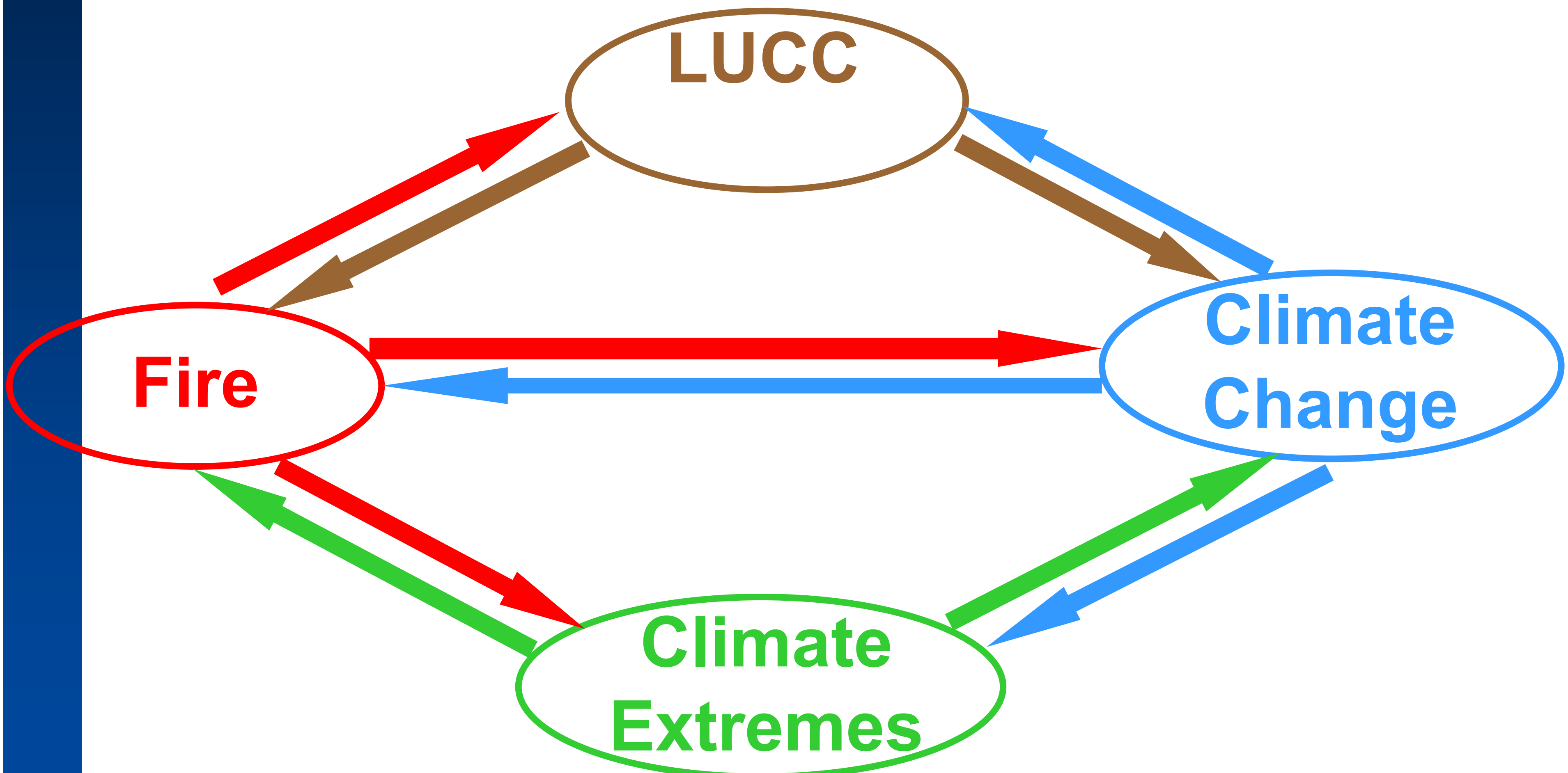


≈17,000 km² avoided deforestation in 3 years (base line at 20,000 km²/year)

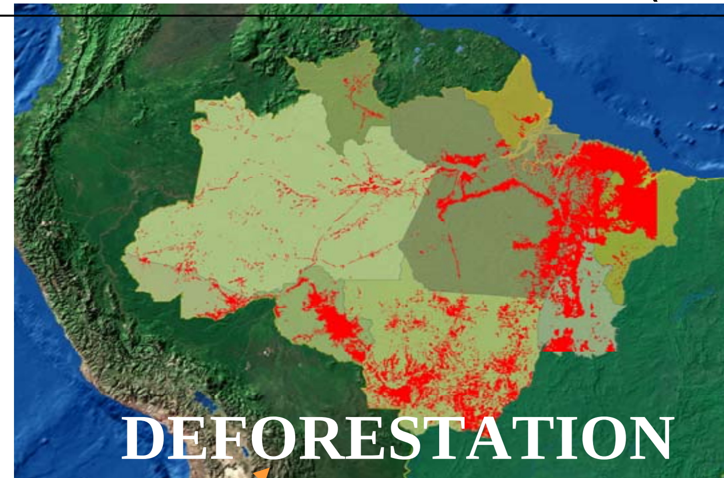
220 Mton C avoided emissions

~ US$ 2.2 bn value in carbon

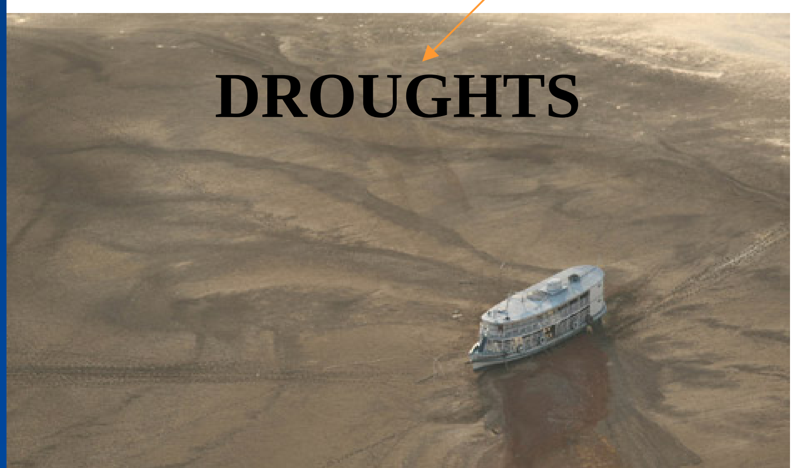
The ecosystems of Amazonia are subjected to a suite of environmental drivers of change



In 2007, total deforested area (clear-cutting) is 700,000 km2 in Brazilian Amazonia (18%)



Anthropogenic and Natural Drivers of Environmental Change in Amazonia



Source: Greenpeace/Daniel Beltra

Are hydrological extremes becoming more frequent?

"The 2005 Western Amazon drought: one of the the most intense drought of the last 100 years"

Northeast Brasil, → the most vulnerable region to climate variability and change

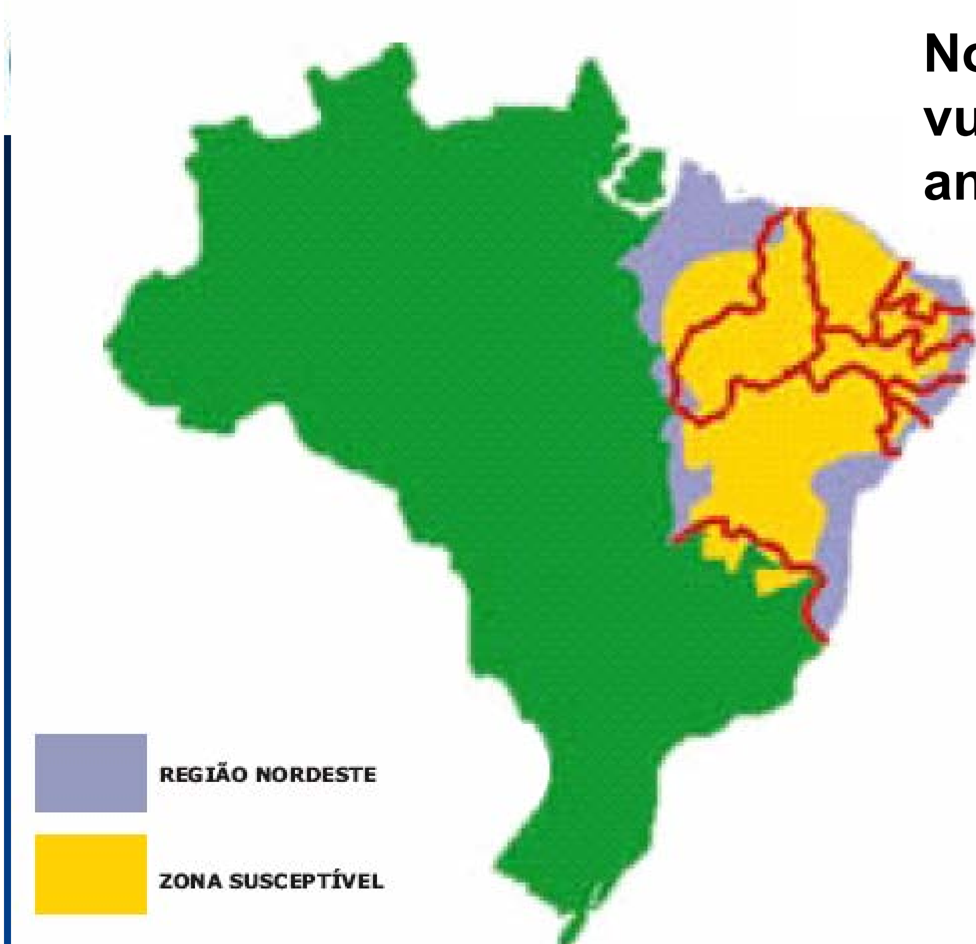
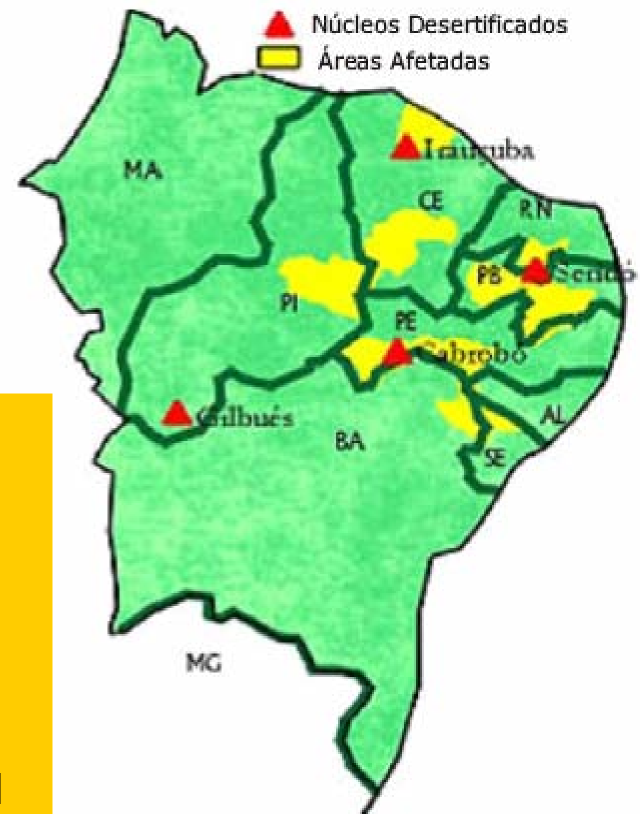


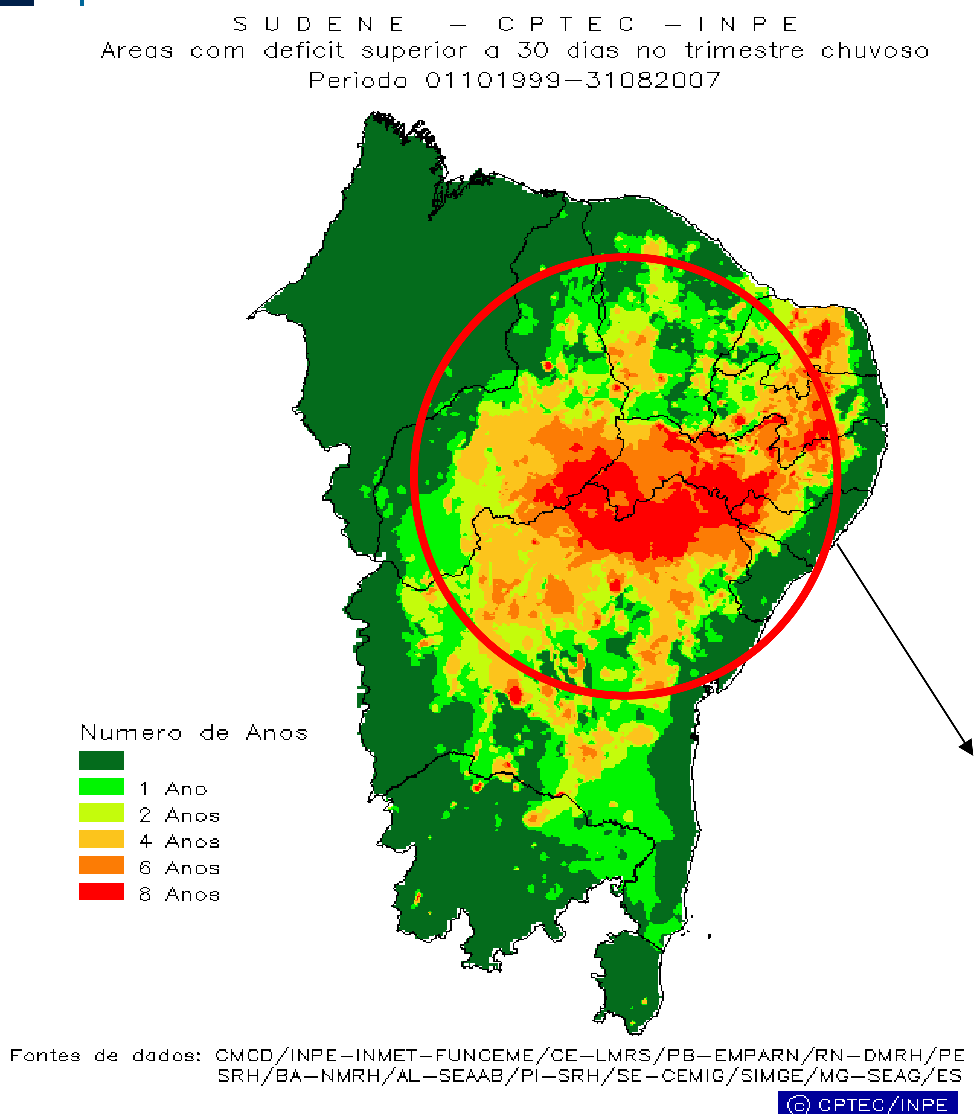
Figura 4.2 - Áreas afetadas e núcleos desertificados



The semiarid region of Northeast Brazil is affected by desertification. It has a population of about 31.6 million people (19% of the total Brazilian population)

-According to the Brazilian Institute for Geography and Statistics (IBGE), the HDI in the Northeast Brazil states reaches 0.517, lower than the national HDI of 0.8. The simarid region of Northeast Brazil (about 86% of the total of the region) exhibits a HDI=0.405.

CGEE MAE (2008)

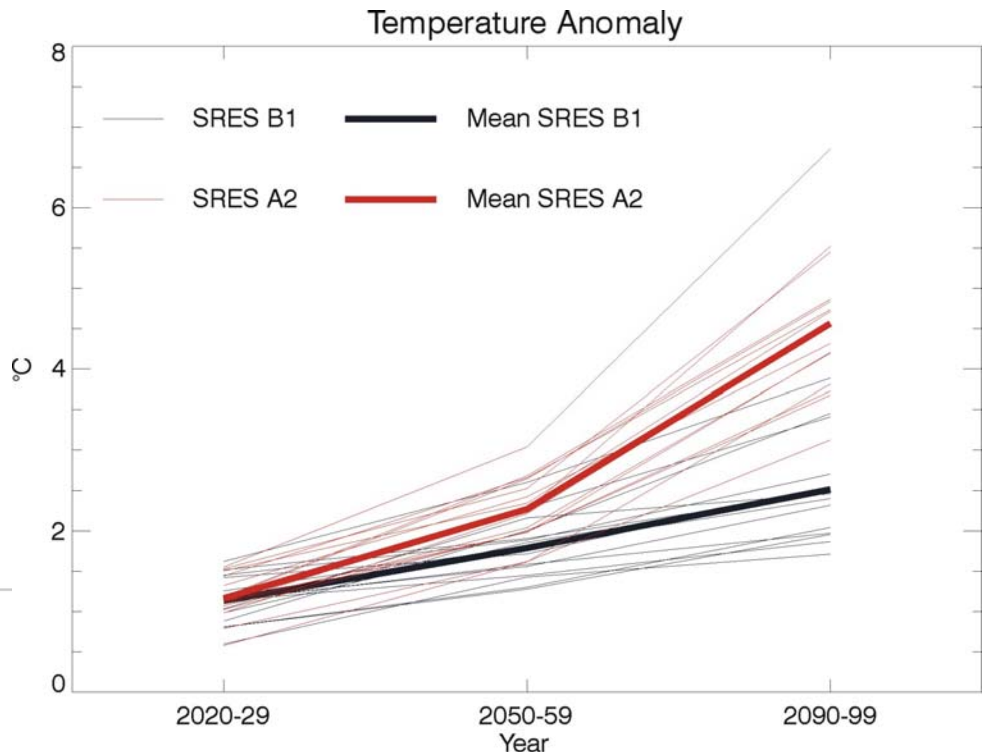


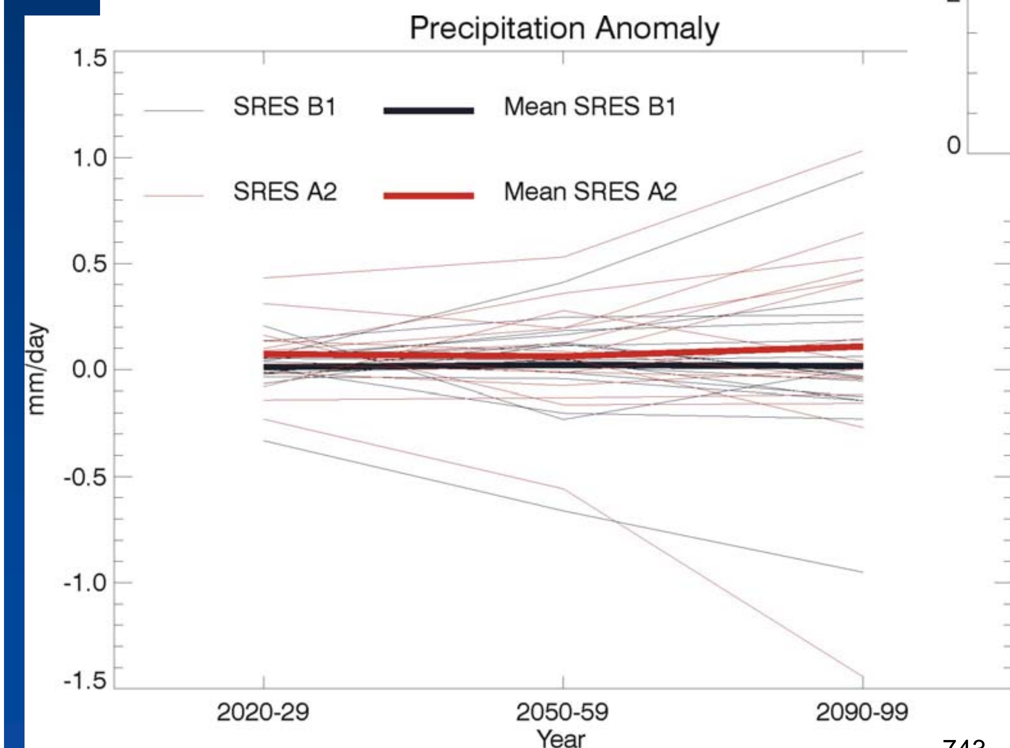
Water stress → Index of vulnerability, aread affected by consecutive drought years during 1999-2007

Semiarid region: Areas affected by 30 consecutive drought days during the rainy season in 1999-2007.

Climate Change projections in South America

Climate Change Scenarios for Amazonia





Results from 15 AOGCMs for the SRES A2 and B1 emissions scenarios, prepared for the IPCC/AR4.

Models: BCCR-BCM2.0, CCSM3, CGCM3.1(T47), CNRM-CM3, CSIRO-MK3, ECHAM5, GFDL-CM2, GFDL-CM2.1, GISS-ER, INM-CM3, IPSL-CM4, MIROC3.2 (MEDRES), MRI-CGCM2.3.2, UKMO-HADCM3, ECHO-G

CLIMATE CHANGE

There is a generalized consensus among IPCC-AR4 models that precipitation changes projected over South America are mainly:

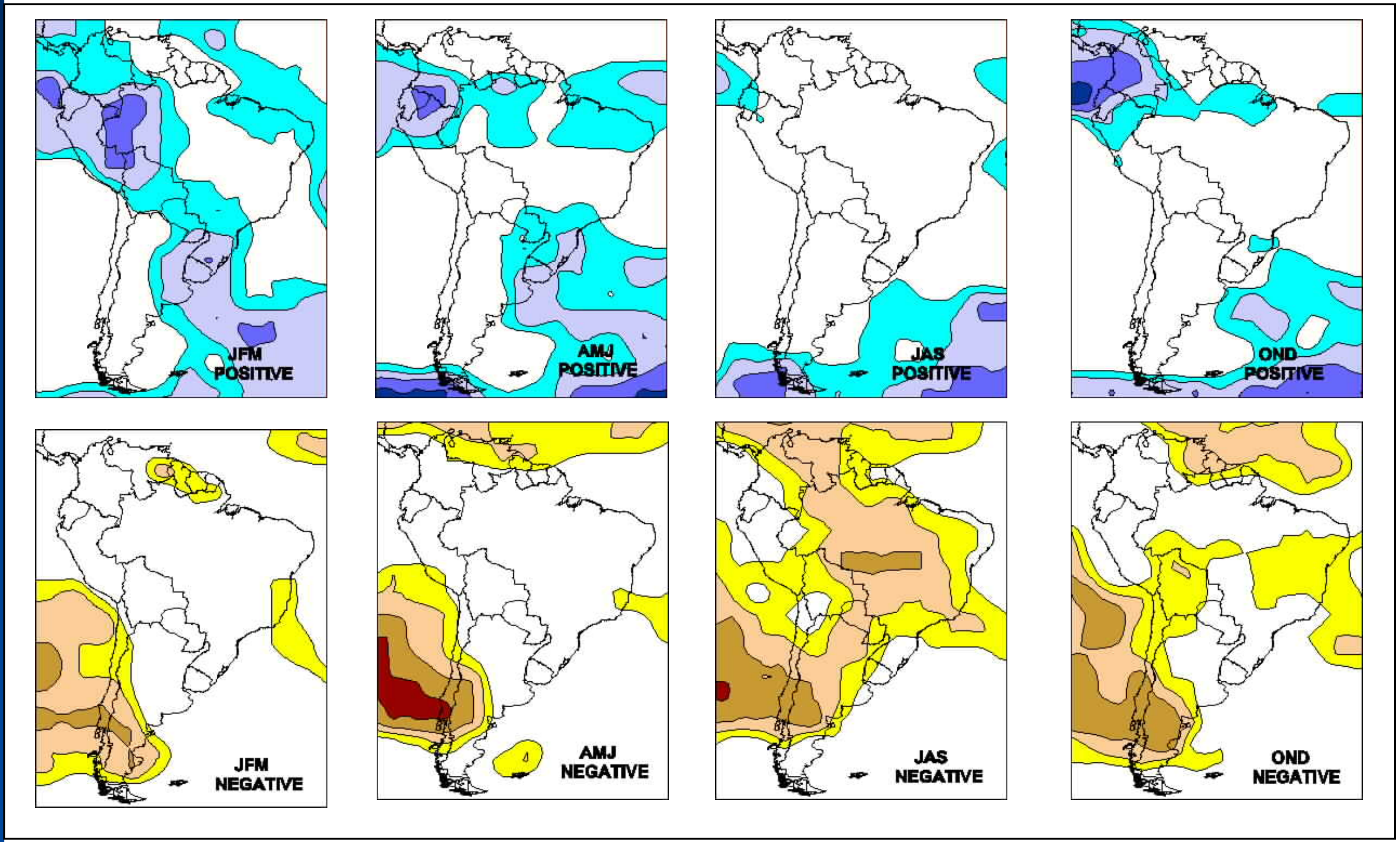
i) Increase of summer precipitation over southeastern subtropical South America and northern Andes;

ii) Reduction of winter precipitation over most of the continent; and

iii) Reduction of precipitation along the southern Andes.

(+)

(-)



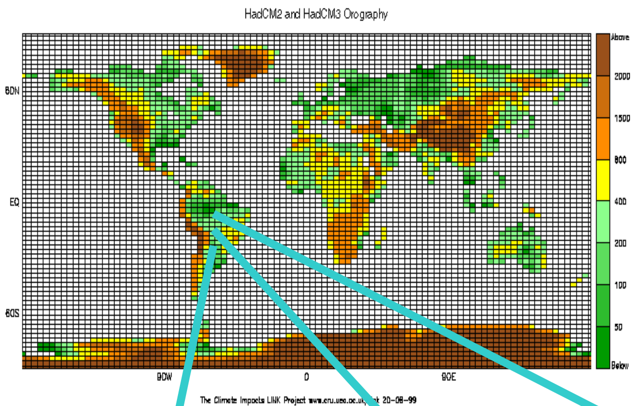
Number of models depicting (1st row) positive changes and (2nd row) negative changes between 2070-2099 and 1970-1999 periods. Contour level is 1, values larger than 4 are shaded.

Vera et al. (2006)

Regional Climate Change Scenarios in South America (INPE, MMA-PROBIO)

Downscaling

Modelos do IPCC: HadAM3

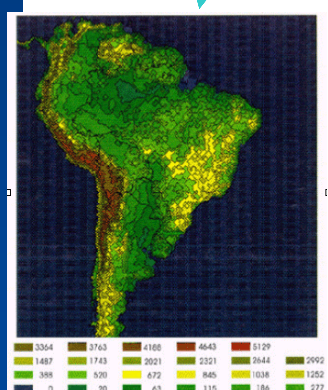


Climatology 1961-90

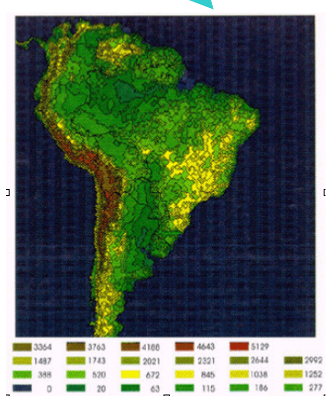
IPCC Scenarios A2, B2

Climate anomalies (future-present), from regional mulimodel ensemble Time slices 2071-2100, A2, B2

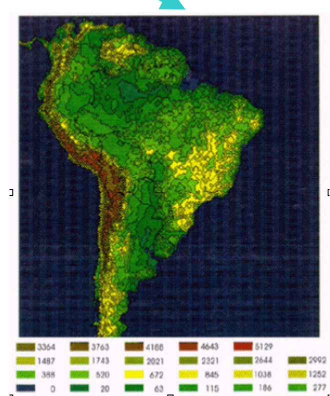
Regional models



RegCM3



HadRM3



Eta CCS

Climatology regional model 1961-90

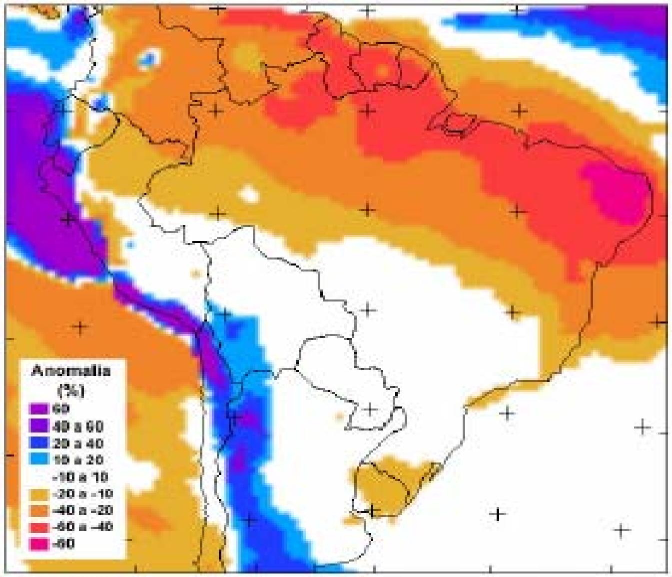
Maps of climate anomalies, and indices of extremes (Regional multimodel ensemble) 2071-2100, A2, B2

Rainfall anomalies (%) (Annual) [(2071-2100)- (1961-90)]

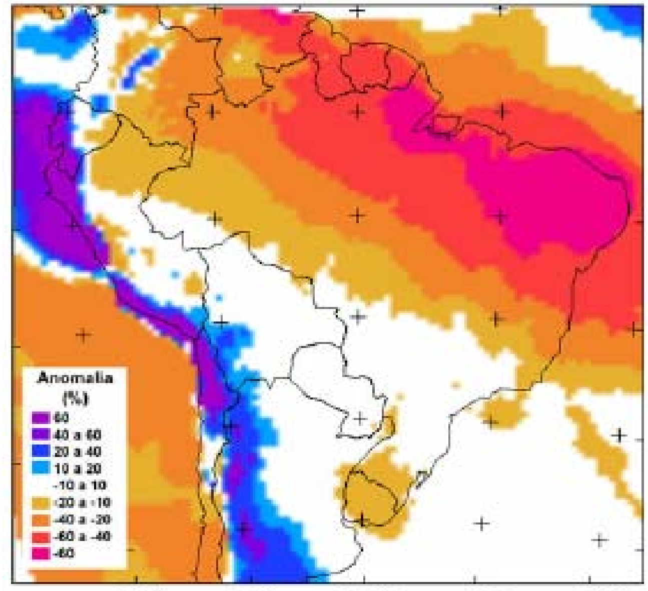
INPE CLIMATE REPORT

CREAS PROJECT
Ensemble of 3 regional models

Marengo et al. (2008)
Ambrizzi et al. (2008)

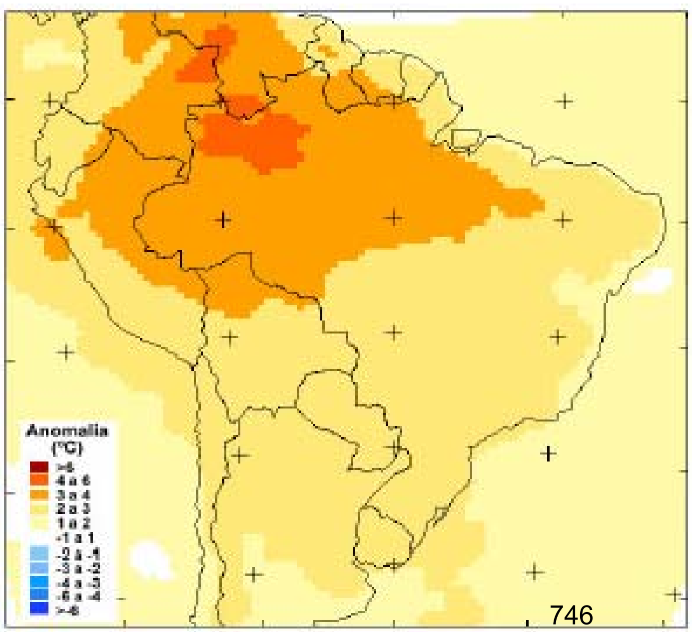


B2

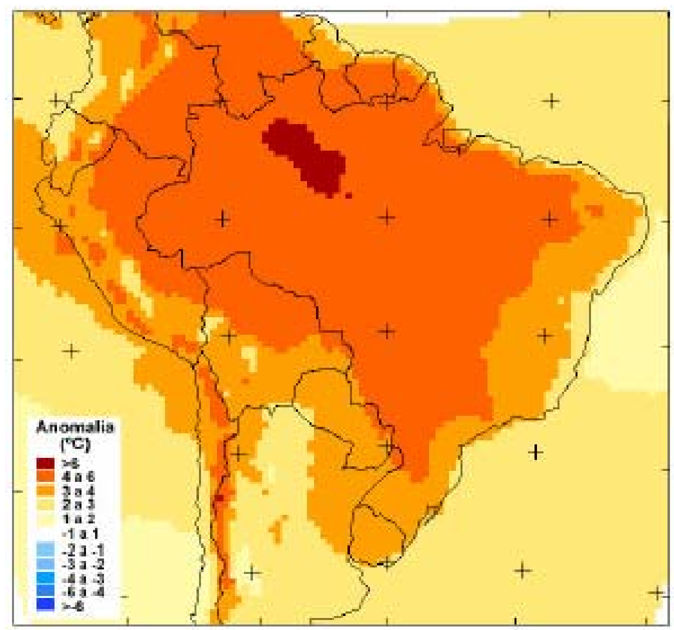


A2

Temperature anomalies (C) Annual [(2071-2100)- (1961-90)]



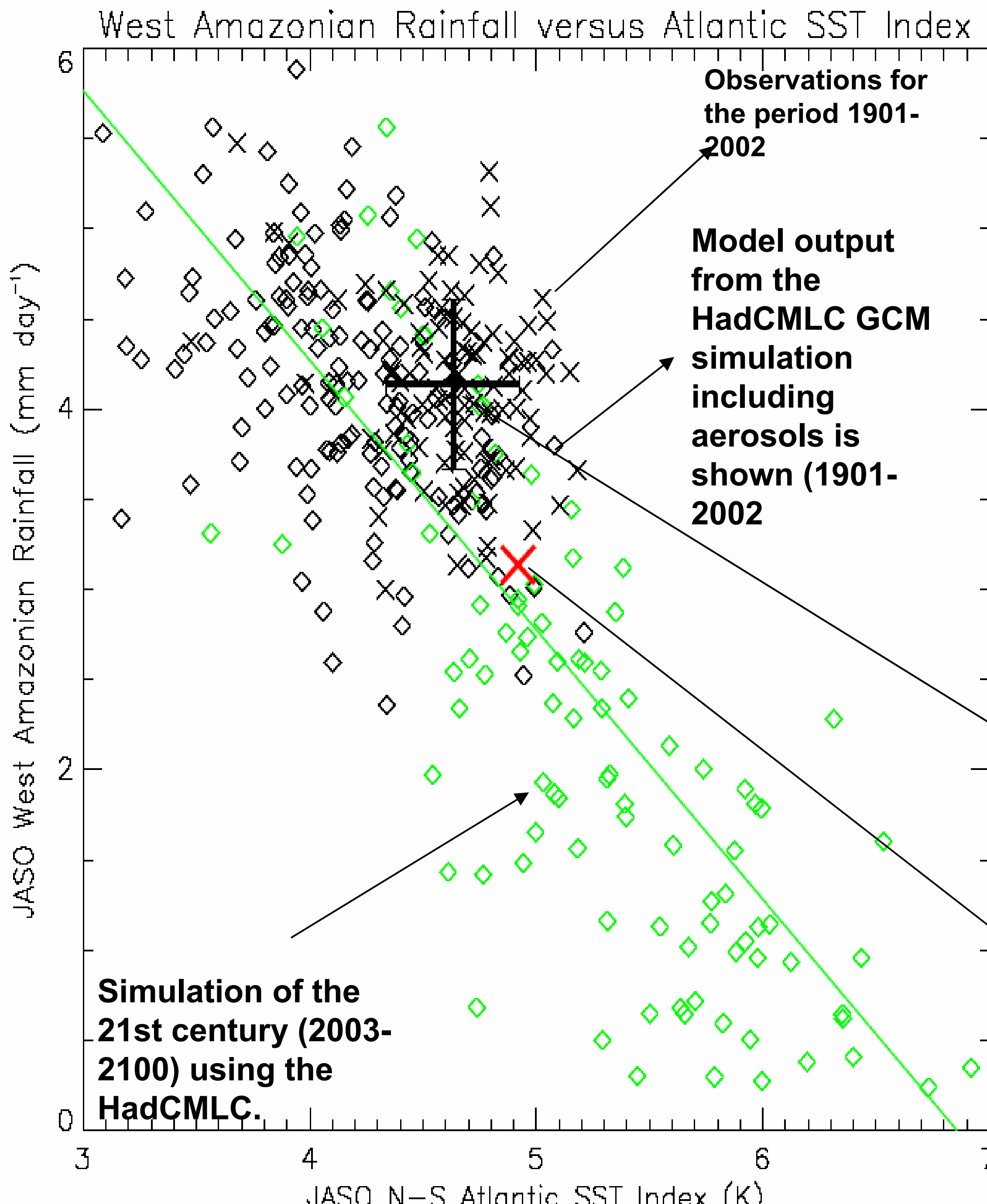
B2



A2

Possible impacts and changes in extremes

INPE, UK Hadley Centre



Drought of Amazonia 2005:

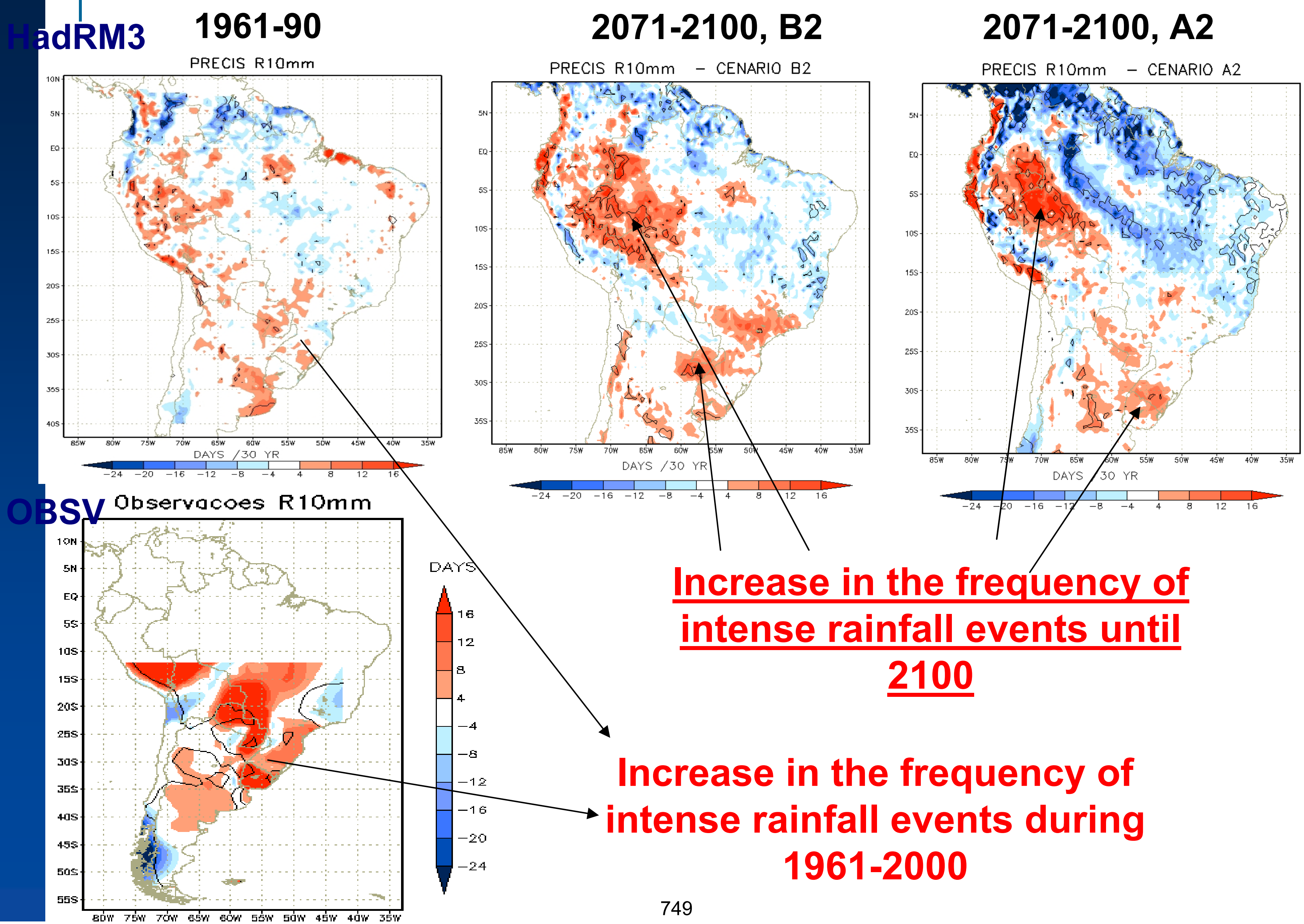
Relationship between July-October anomalies in rainfall in Western

Amazonia and in the Index of the north-south SST gradient across the tropical Atlantic ocean (Cox et al. 2008, Marengo et al. 2008 a, b)

Mean and STDV of the observation,

Mean and STDV estimated values for the 2005 Amazon drought→ a sample of what may come in the future!!

PRECIS-Intense rainfall index (R10) [(2071-2100)- (1961-90)]



Increase in the frequency of intense rainfall events until 2100

Increase in the frequency of intense rainfall events during 1961-2000

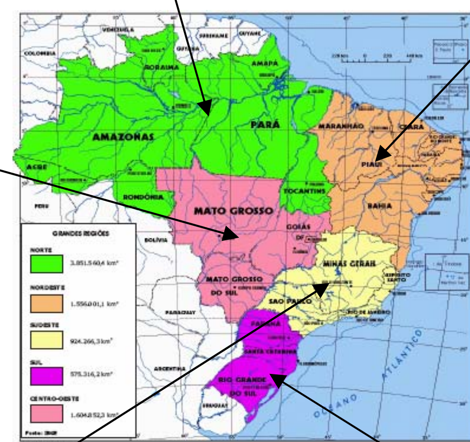
Summary of future climate change scenarios for the end of the XXI Century and possible impacts in Brazil

INPE

AMAZON REGION
A2: 4-8 C warmer, 15-20% less rainfall.
B2: 3-5 C warmer, 5-15 % less rainfall
Possible impacts: High frequency of dry spells in eastern Amazonia and intense rainfall events in western Amazonia, losses in natural ecosystems, rain forest and biodiversity. Low river levels affecting transportation and commerce. Possible impacts on moisture transport and rainfall in Southeastern South America. Impacts on hydroelectric generation. More favorable conditions for spread of forest fires. Impacts on health and commerce due to smoke.

NORTHEAST BRAZIL
A2: 2-4 C warmer, 15-20% less rainfall.
B2: 1-3 C warmer, 10-15 % less rainfall
Possible impacts: High frequency of dry spells and evaporation rates and low soil moisture levels affecting levels of channels and reservoirs. Losses in natural ecosystems caatinga.Tendency towards aridization and desertification in the semiarid region. Water scarsity. Waves of climate refugees migrating towards large cities agravating social problems. Impacts on human health

WEST CENTRAL BRAZIL
A2: 3-6 C warmer,
B2: 2-4 C warmer,
Possible impacts: High frequency of intense rainfall events and dry spells. High evaporation rates and lower soil moisture can affect agriculture (coffee) and hydroelectric generation. Soil erosion due to high temperatures and intense dry spells can affect agriculture and natural ecosystems Pantanal and cerrado. .



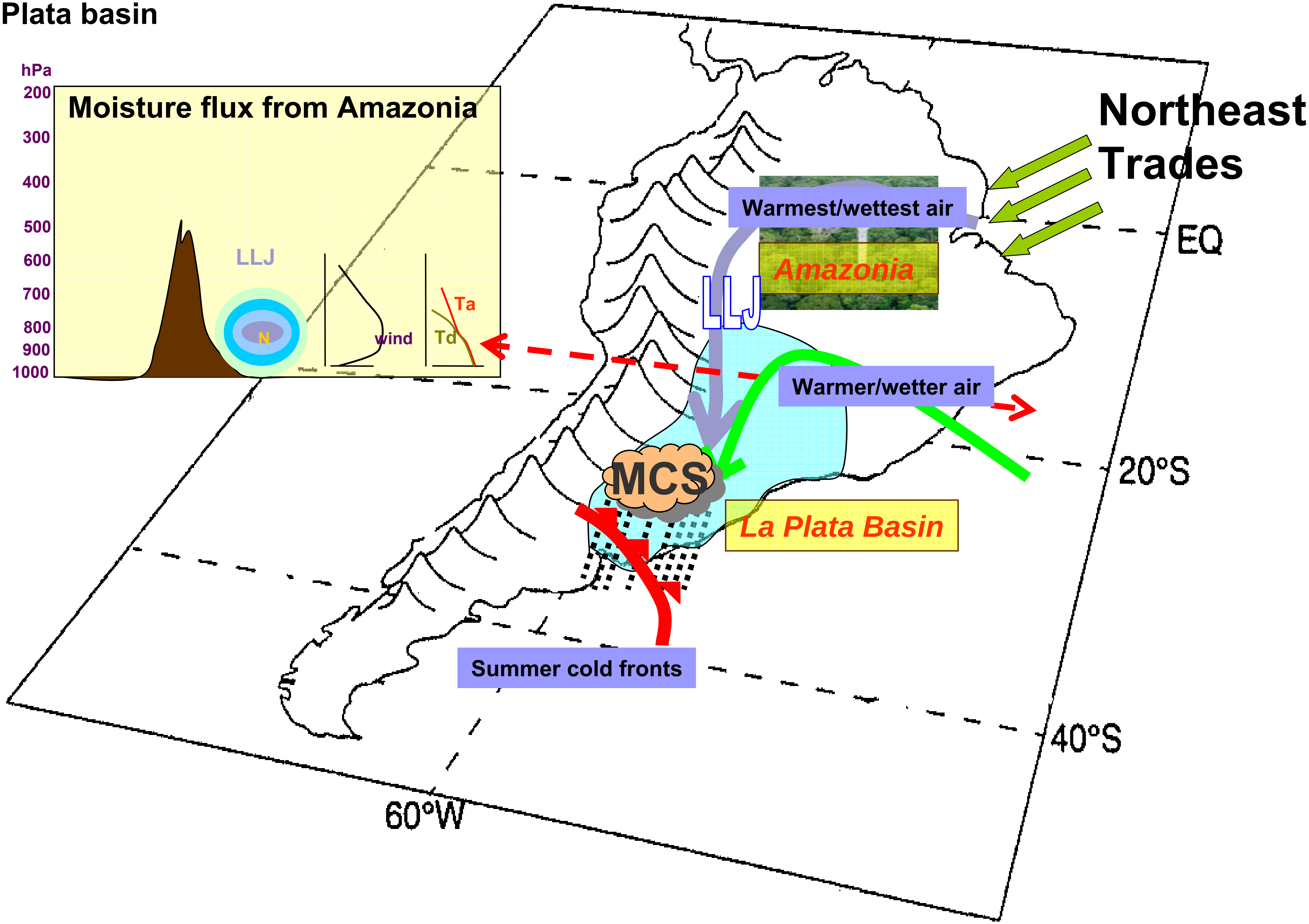
SOUTHERN BRAZIL
A2: 2-4 C warmer, 5-10% more rainfall.
B2: 1-3 C warmer, 0-5 % more rainfall
Possible impacts: High frequency of intense rainfall events, increase in warm nights frequency (reduction of cold nights). Intense rainfall and high evaporation due to dry spells can affect agriculture (weath and soybean). Losses in natural ecosystems. High temperatures and intense rainfall can affect human health

SOUTHEASTERN BRAZIL
A2: 3-6 C warmer,
B2: 2-3 C warmer,
Possible impacts: High frequency of intense rainfall events. High evaporation rates and lower soil moisture can affect agriculture (coffee) and hydroelectric generation. High temperatures and intense rainfall can affect human health. Possible sea level rise.

Sources: INPE, MMA-PROBIO, EMBRAPA, CEPAGRI

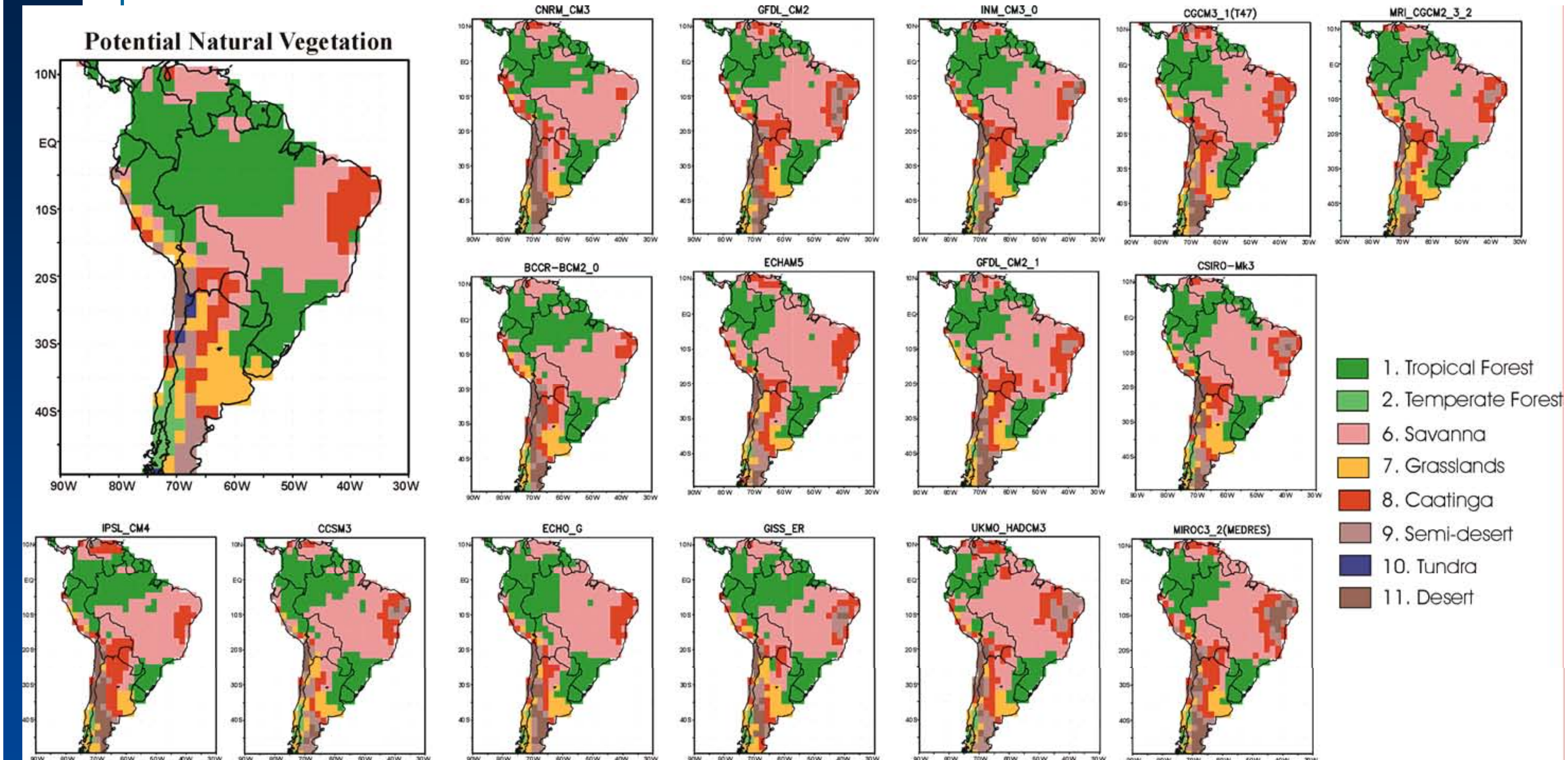
Climate Change in Amazonia may induce climate change in the Parana-La Plata basin

INPE



What are the likely biome changes in Tropical South America due to Global Warming scenarios of climate change?

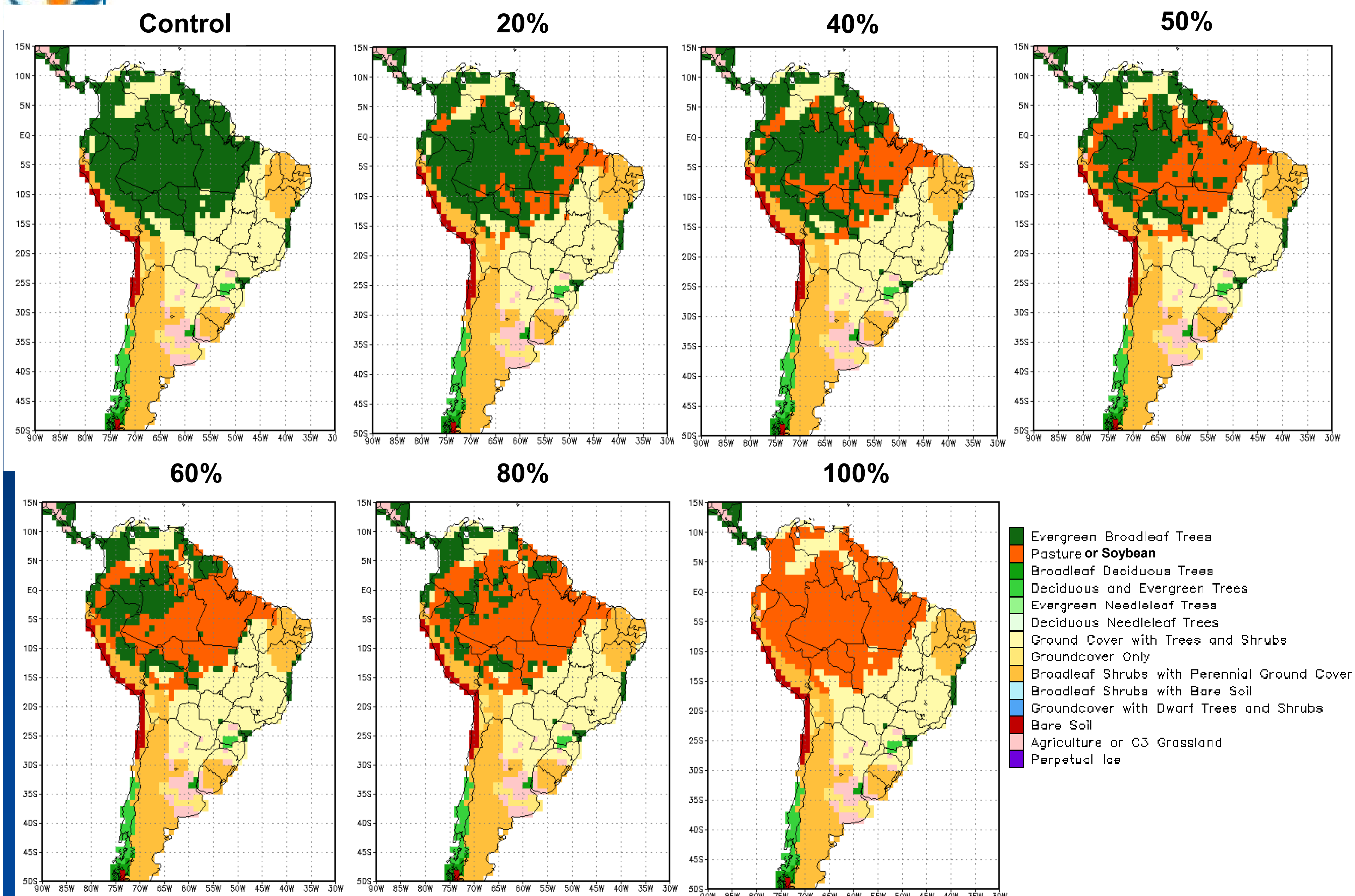
Climate Change Consequences on the Biome distribution in tropical South America



Projected distribution of natural biomes in South America for 2090-2099 from 15 AOGCMs for the A2 emissions scenarios, calculated by using CPTEC-INPE PVM.

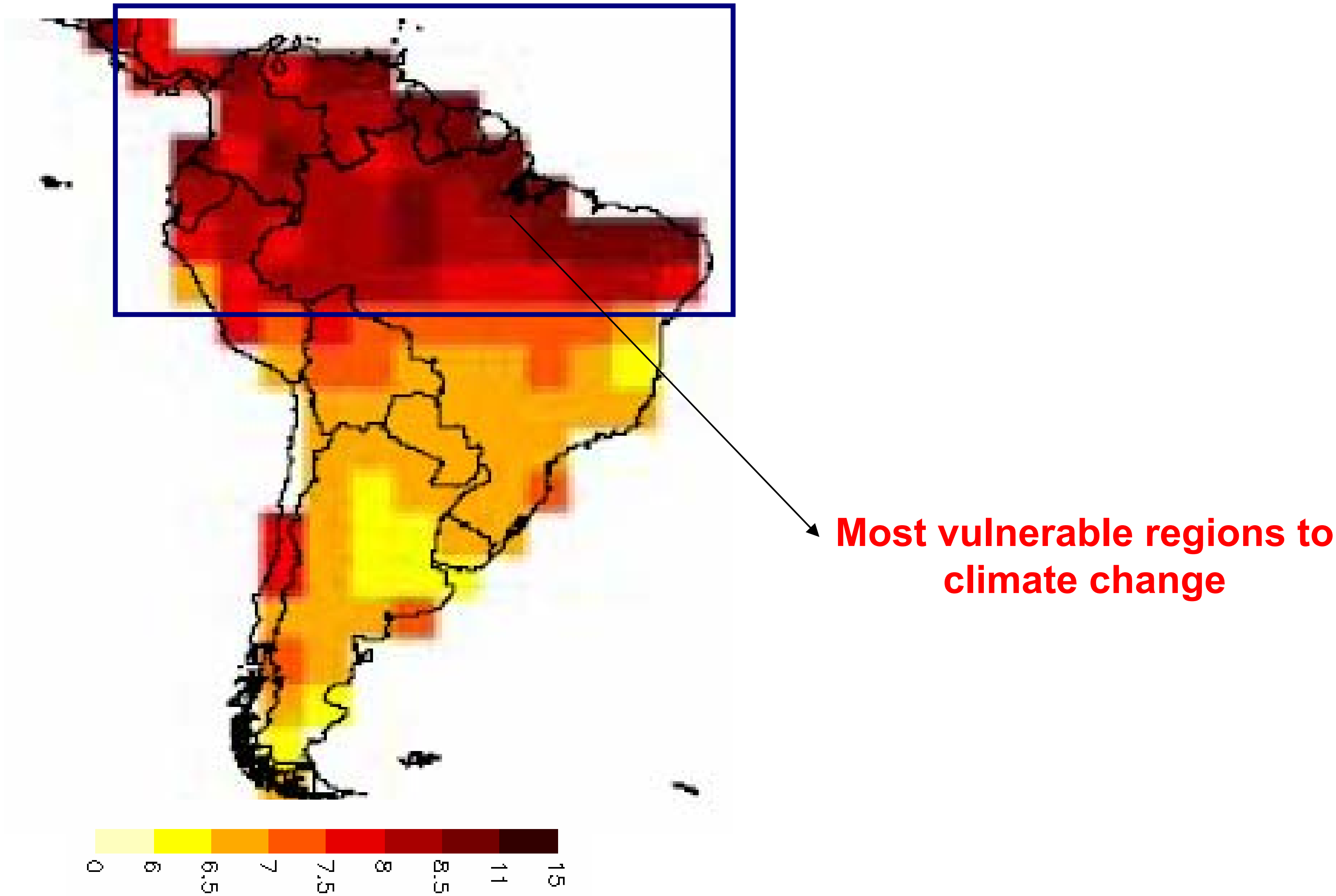
Salazar et al., 2007

Yes- About 40% of deforestation (Sampaio 2008)

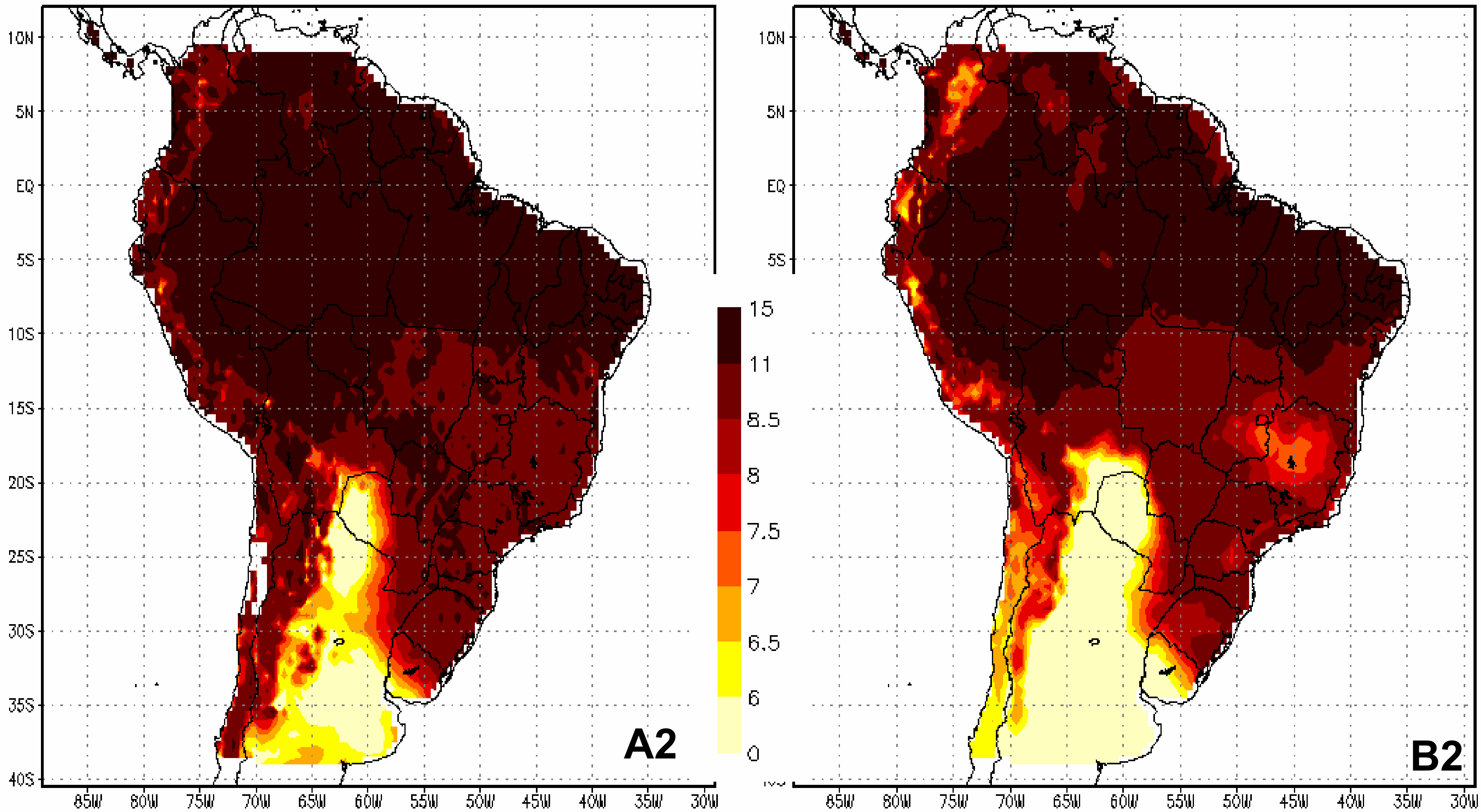


Source: Soares-Filho et al., 2006 - Amazon Scenarios Project, LBA

Values of the CCI (Climate Change Index) for South America (Baettig et al. 2007) for 2071-2100 relative to 1961-90. Map was derived using the IPCC AR4 AOGCMs for A2 scenario.



Values of the CCI (Climate Change Index) for South America. Mean from 3 regional climate models (50 km), using Baettig´s methodology, for 2071-2100 relative to 1961-90. CLIMATE CHANGE VULNERABILITY INDEX



Climate change: Official statistics + Research = Vulnerability, mitigation, adaptation

Official Statistics (environmental-climate, hydrology, land use change, social, economical...)→ Monitoring, projections for the future

Research community: modelling, data processing and statistical analyses, new methods for vulnerability and risk assessments,

Production of integrated vulnerability indices (HDI, ..) and definition of new indices of vulnerability

Impact studies, vulnerability assessments, mitigation strategies

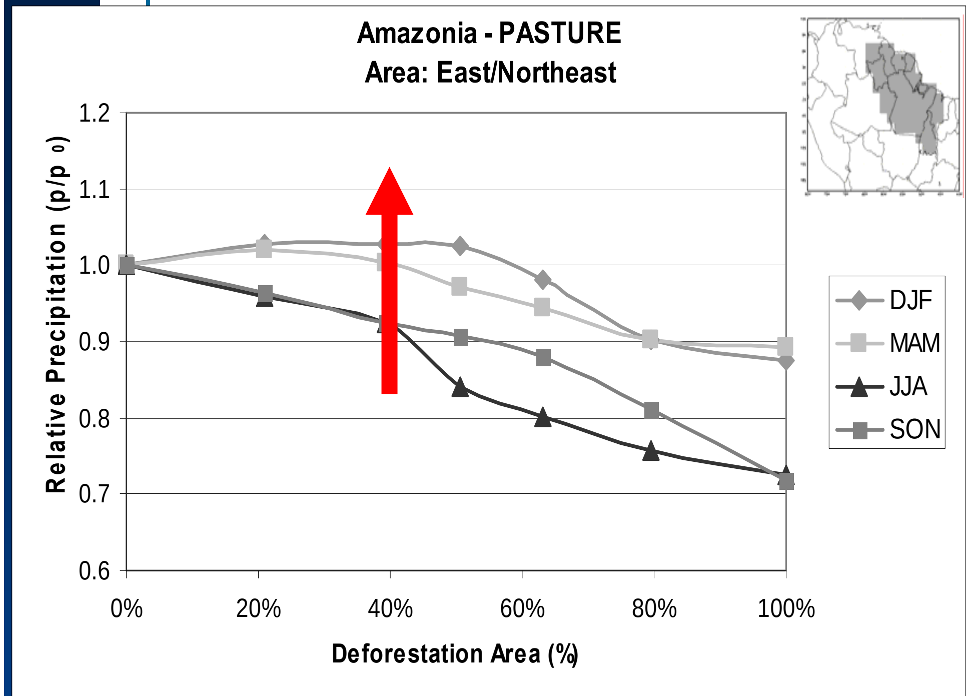
Regional, sectorial analyses of vulnerability to climate change (agriculture, health, energy, biodiversity...)

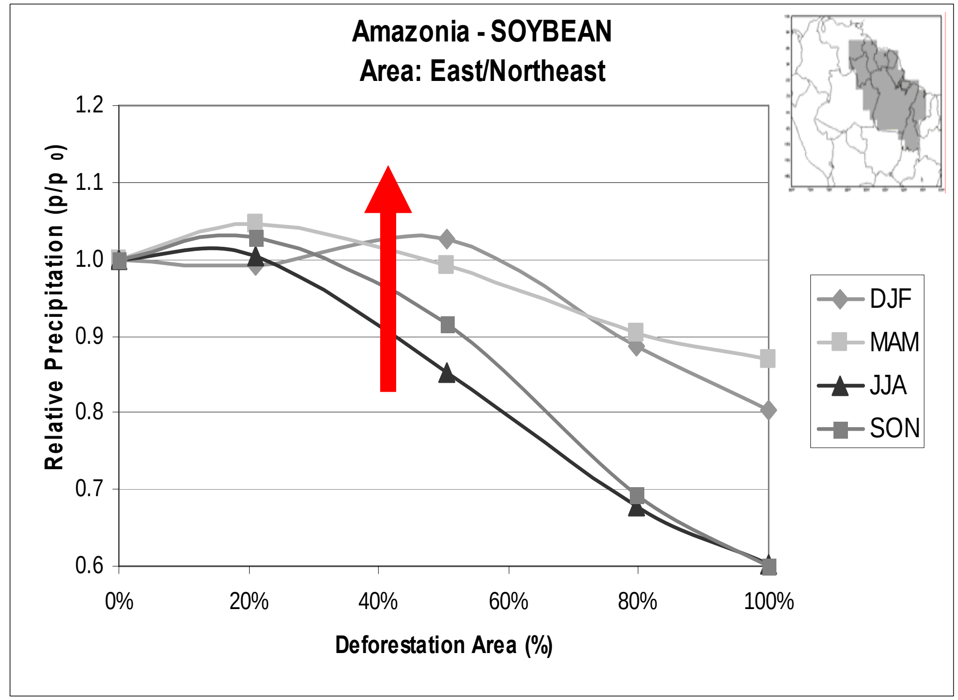
Environmental policies directed to mitigation and adaptation

Reduction in GHG emissions, in deforestation, biofuels

Precipitation

PASTURE **SOYBEAN**





Precipitation Anomaly (%)

Season	All Pasture	All Soybean
JJA	**-27.5%**	**-39.8%**
SON	**-28.1%**	**-39.9%**

The reduction in precipitation is larger during the dry season, and is more evident when the deforested area is larger than 40% !

Sampaio et al., 2007

Environmental services, adaptation and mitigation options

The ethical dimensions of Global Environmental Change

This is an issue of ethics and justice: the people [and other forms of life] most likely to bear the brunt of Global Environmental Change are those who have contributed least to it

Historical contributions to CO_2 emissions:

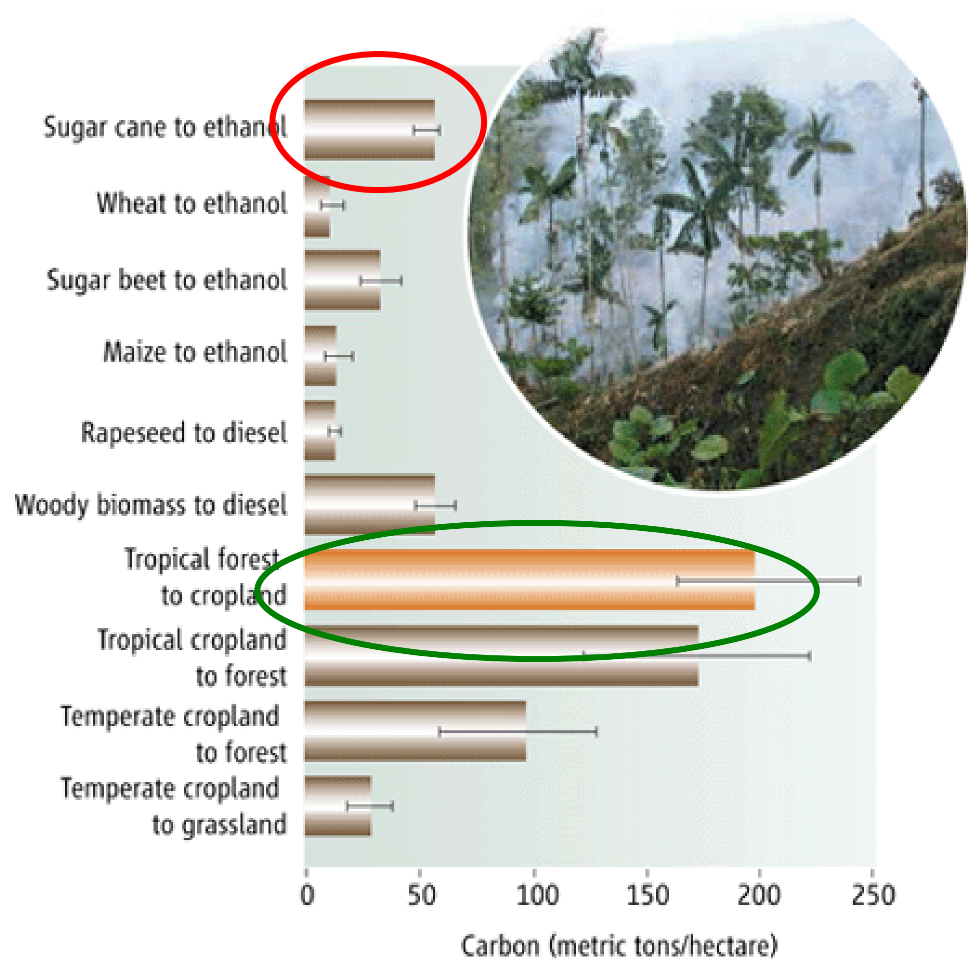
Europe	30%
USA	28%
China	8%
Amazonia	1%

Main environmental services provided by tropical forest

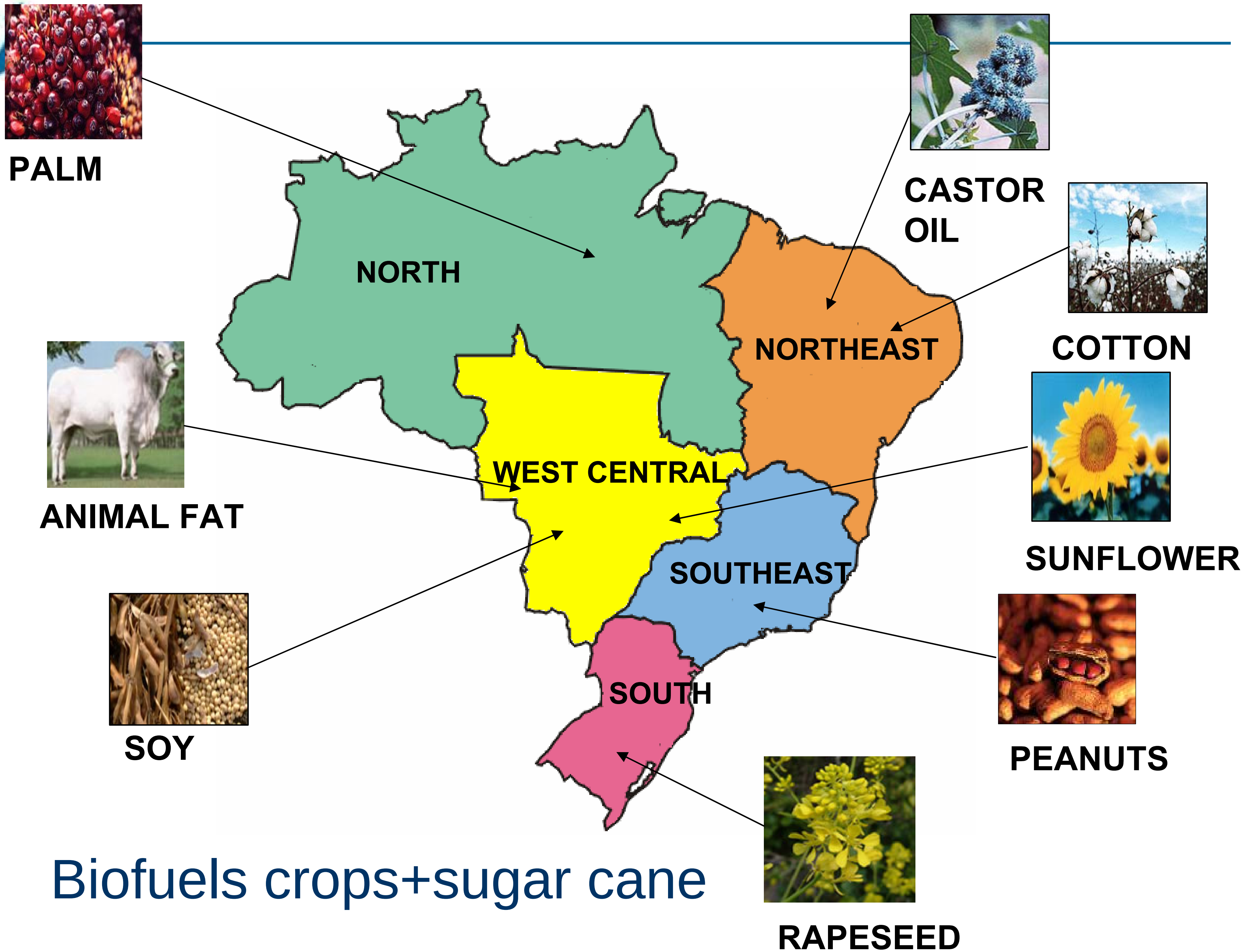
- Stability of the hydrological cycle and climate in the region
- Stability of soil and agriculture
- Carbon storage, storing and sequestering carbon
- Moisture recycling and transport to other regions
- Keeping large biodiversity
- Opportunities for ecological services and sustainable use of resources

Biofuels are no panacea …

- **If the prime object of biofuels is mitigation of CO_2-driven global warming, in the short term (30 years or so) it is better to focus on increasing the efficiency of fossil fuel use**
- **Conversion of large areas of land to biofuel crops may place additional strains on the environment**



Righelato and Spracklen, *Science* 17.Aug.2007



Biofuels crops+sugar cane

- Climate change is a serious issue in Brazil, changes in extremes have been affecting population and possible impacts may have large social, economical and political impacts: eg. drought of Amazonia in 2005

- The synergistic combination of regional climate changes caused by both global warming and land cover change over the next several decades, exacerbated by increased drought and forest fire frequency, could tip the biome-climate state to a new stable equilibrium with '*savannization*' of parts of Amazonia and catastrophic species losses, and "*aridization*" in Northeast Brazil, with huge negative social impacts

- CO_2 "fertilization" effects could increase forest resilience, but with less efficiency with continued warming and deforestation.

- Biofuel use does not guarantee reduction in GHG emissions

- Reduction in emission of GHG from industrial activities and from deforestation is a major goal from the Brazilian Govermenmt, keeping in mind that the economical growth of Brazil should continue in a sustainable development goal

- Need for a strong interaction between academics and goverment

World Data Center for Human
Interactions in the Environment

UN Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

Why Demographic Data are not Up to the Challenge of Measuring Climate Risks, and What to do about it

CIESIN

Columbia University

CIESIN Columbia University

Introduction

World Data Center for Human Interactions in the Environment

- AR4 (Schneider *et al*. 2007: 782):
  - An *impact* describes a specific change in a system caused by its exposure to climate change. Impacts may be judged to be either harmful or beneficial.
  - *Vulnerability to climate change* is the degree to which these systems are susceptible to, and unable to cope with, the adverse impacts.
  - The concept of *risk*, which combines the magnitude of the impact with the probability of its occurrence, captures uncertainty in the underlying processes of climate change, exposure, sensitivity and adaptation

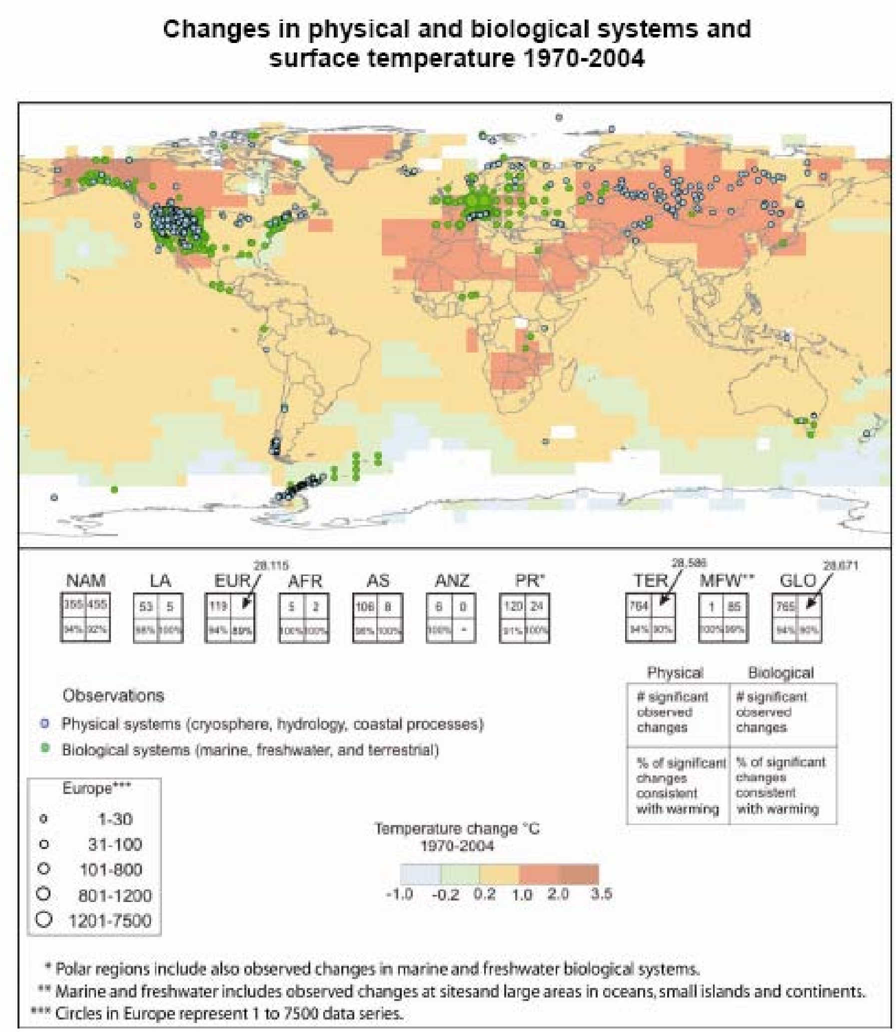
Introduction (cont.)

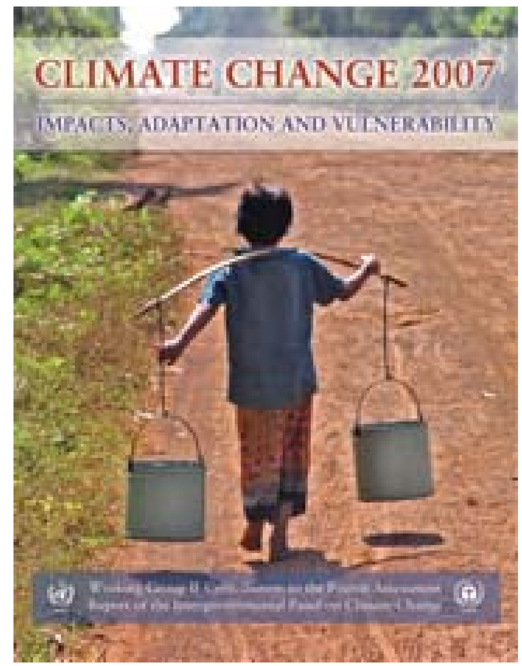
World Data Center for Human Interactions in the Environment

- Layers of vulnerability
  - Everyone is vulnerable to climate change to some extent, it is an issue that cuts across socioeconomic status, settlement type or degree of development. *Someone or something is vulnerable just by virtue of being present at the place and time of occurrence of the particular hazard.* This is the external dimension of vulnerability, that of exposure.
  - However, not everyone in a specific situation shows the same *degree of vulnerability*, and this is related to the internal dimension, that of defenselessness. Multiple layers of vulnerability may be added because of the influence of group, household and individual characteristics such as age, gender, race or ethnicity, education, household composition, life cycle, etc.

IPCC AR4 Observed Effects

World Data Center for Human Interactions in the Environment





Climate Changes Are Under Way

World Data Center for Human Interactions in the Environment

Changes in temperature, sea level and Northern Hemisphere snow cover

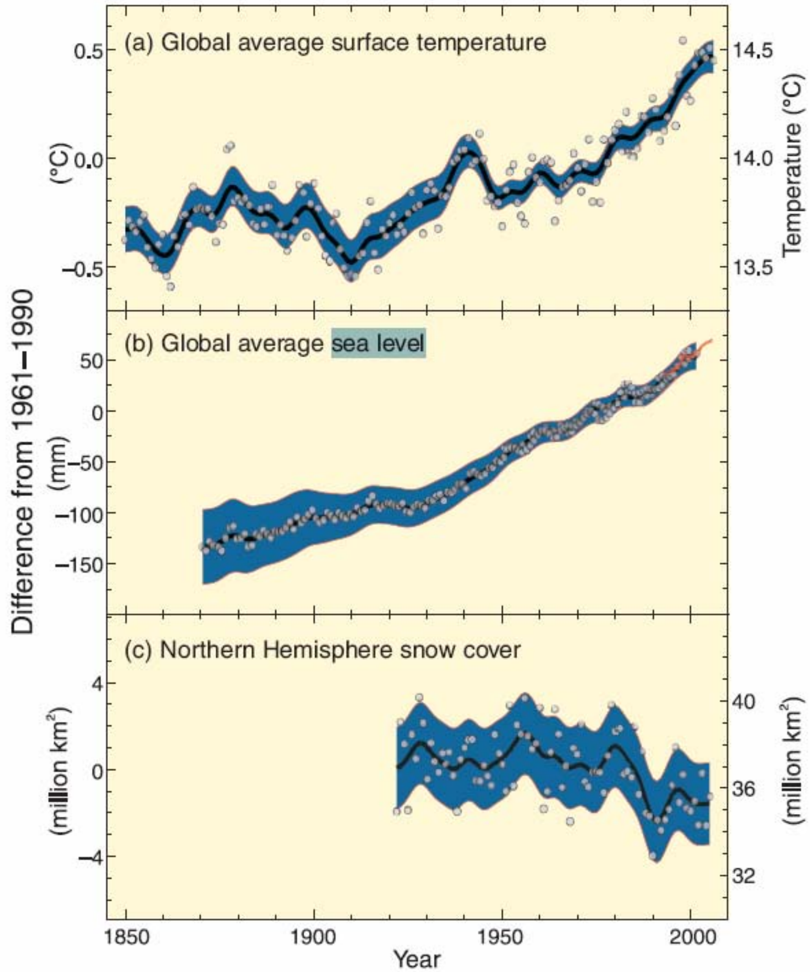


Figure SPM.1. Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). {Figure 1.1}

From IPCC AR4 Summary for Policymakers

Rapid Deglaciation of Greenland Ice Sheet?

World Data Center for Human Interactions in the Environment

- Greenland ice could raise sea levels up to 7 m

Melt descending into a moulin, a vertical shaft carrying water to ice sheet base

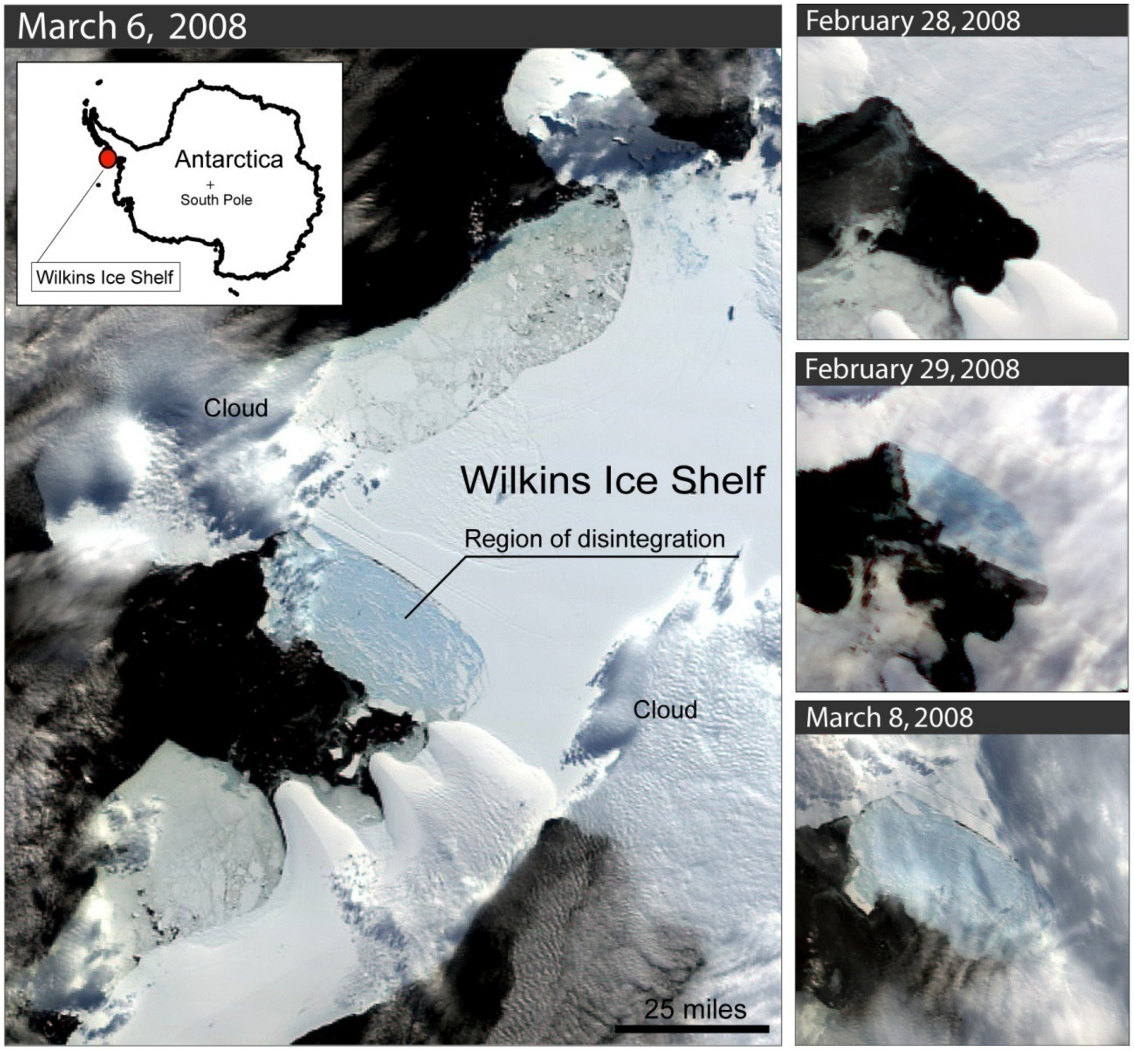
Source: Roger Braithwaite, University of Manchester (UK). Slide courtesy James Hansen

Jakobshavn Ice Stream in Greenland. Discharge from major Greenland ice streams is accelerating markedly.

Source: Prof. Konrad Steffen, Univ. of Colorado. Slide courtesy James Hansen

Collapse of the West Antarctic Ice Sheet?

- Wilkins Ice Shelf disintegrated recently
- One of a string of ice shelves that have collapsed in the West Antarctic Peninsula in the past thirty years.
  - Larsen B in 2002
- West Antarctic ice could add 5 meters to sea level rise
- Remainder of Antarctic ice ~50 m



National Snow and Ice Data Center, Boulder, CO

Impacts of Climate Change, Examples

On Ecosystems:

Over the course of this century, net carbon uptake by terrestrial ecosystems is likely to peak before mid century and then weaken or even reverse, thus amplifying climate change

On Industry, Settlements, and Society:

The most vulnerable industries, settlements and societies are generally located in coastal and river flood plains, with economies closely linked to climate-sensitive resources and in areas prone to extreme weather events, esp. where rapid urbanization is occurring

Poor communities can be especially vulnerable, particularly those concentrated in high-risk areas

(AR4 Synthesis Report, p. 48)

In view of the fact that climate change impact and resulting vulnerability is inherently spatial, we now look at three challenges faced by national statistical offices in integrating data from a variety of sources to assess vulnerability

CIESIN Columbia University

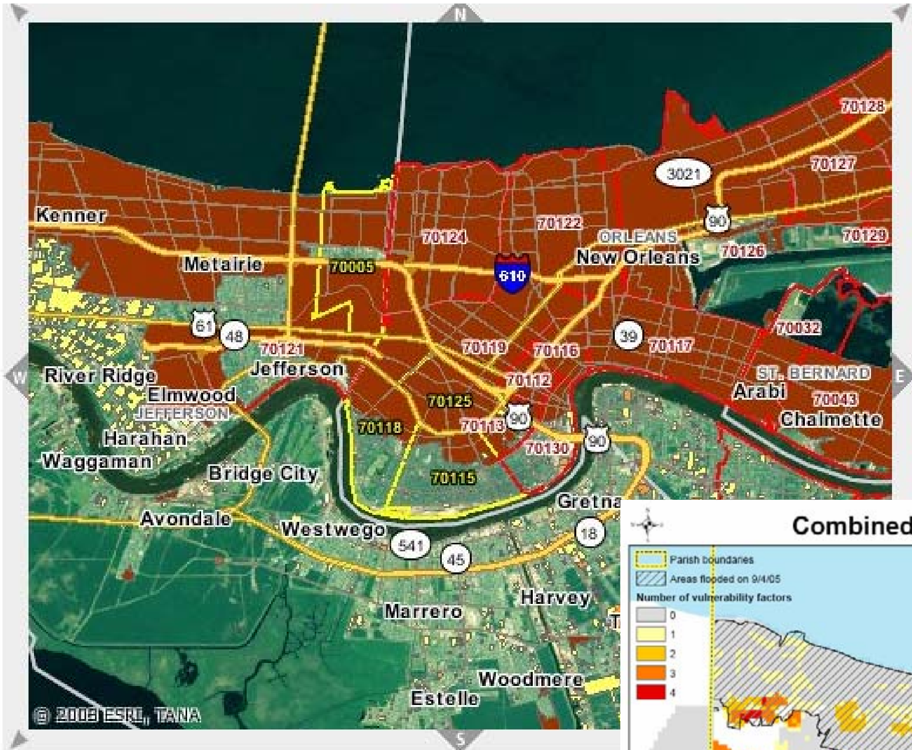
Challenge 1

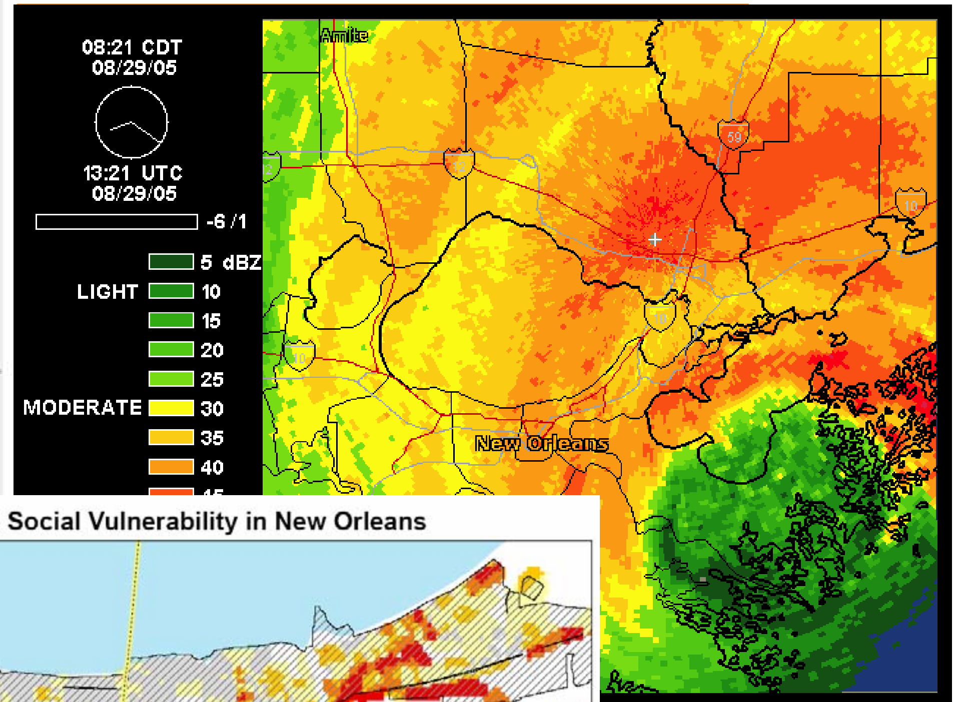
World Data Center for Human Interactions in the Environment

- 1) National census units are not well-delineated in geographic space, making it very difficult to locate human populations with respect to climate risks; this is especially problematic concerning coastlines and sea-level rise risks.

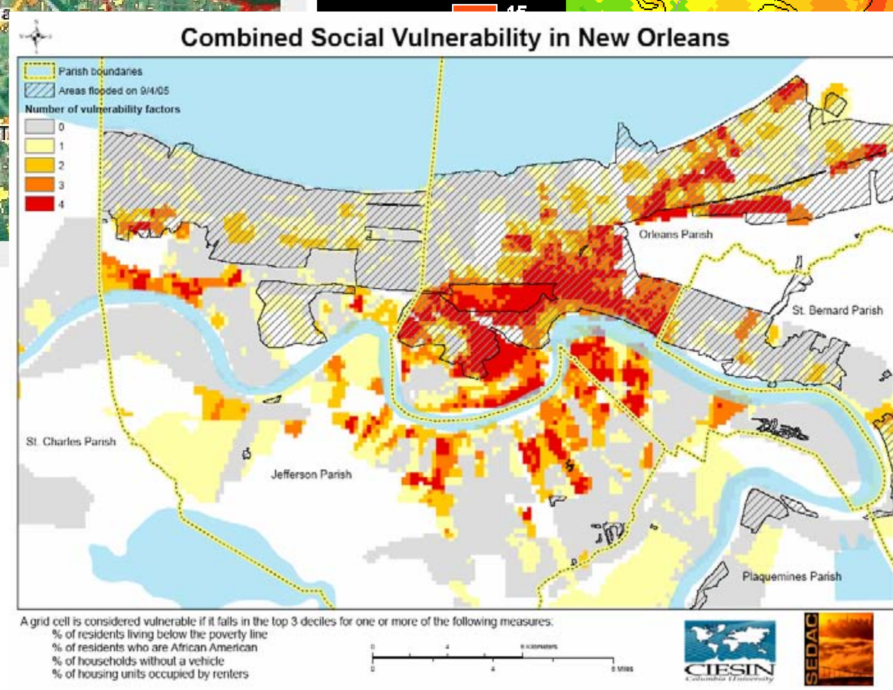
Integrating data to assess vulnerability

World Data Center for Human Interactions in the Environment





Hazard

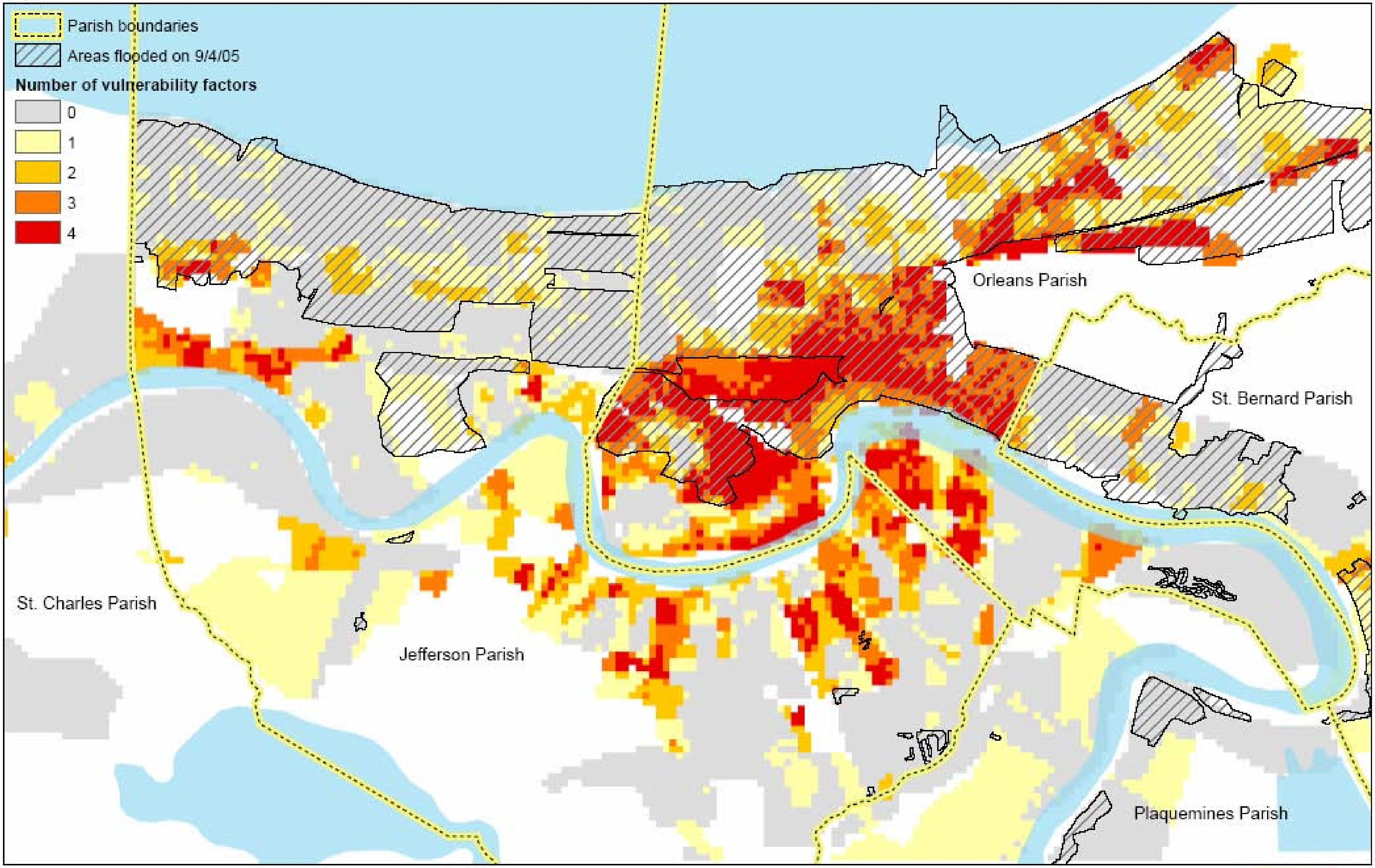


Exposure (location) + defenselessness (individual, household and community characteristics)

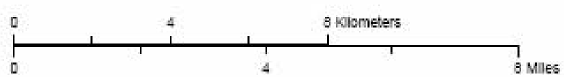
= RISK!

11

Combined Social Vulnerability in New Orleans



A grid cell is considered vulnerable if it falls in the top 3 deciles for one or more of the following measures:
- % of residents living below the poverty line
- % of residents who are African American
- % of households without a vehicle
- % of housing units occupied by renters



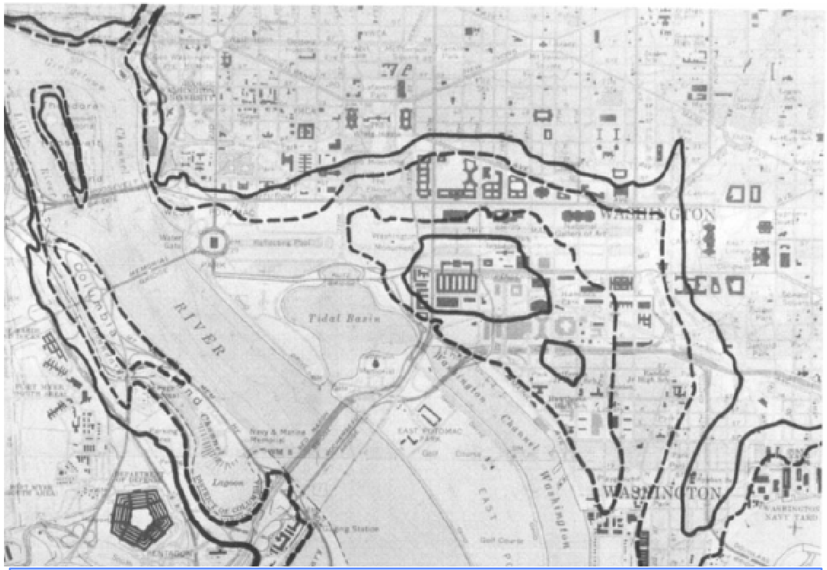
CIESIN Columbia University

SEDAC

Early studies assessed potential impacts of sea level rise

CIESIN Columbia University

World Data Center for Human Interactions in the Environment



Ann. Rev. Energy. 1980. 5:107-40

CARBON DIOXIDE WARMING AND COASTLINE FLOODING: Physical Factors and Climatic Impact

❖11078

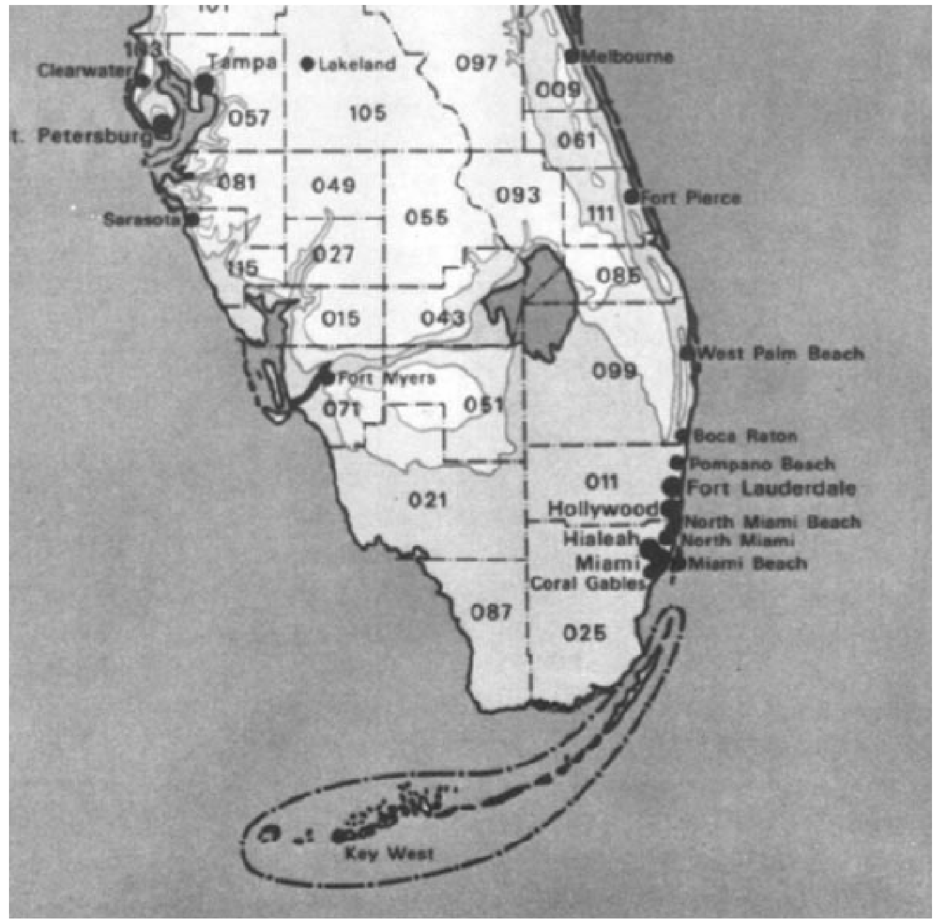
Stephen H. Schneider and Robert S. Chen[1]

National Center for Atmospheric Research,[2] Boulder, Colorado 80307

INTRODUCTION

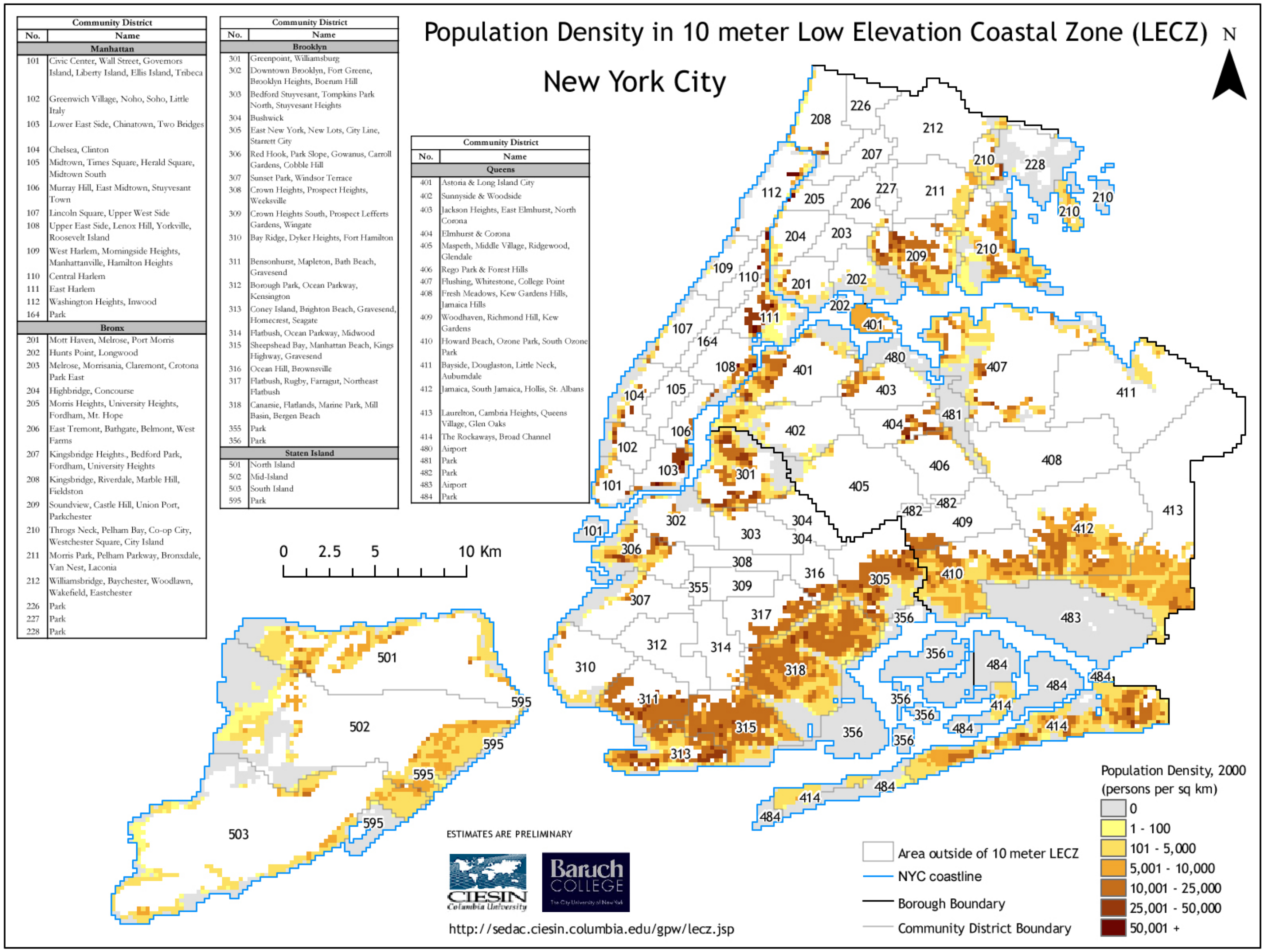
Carbon dioxide concentration is known to be increasing in the atmosphere, and some calculations project about a 20% increase over present levels by 2000 AD and a doubling by the middle of the next century (1–9). CO_2 increases are associated with increasing use of fossil fuels (10, 11) and

- Potential impacts of 5- to 8-m rise on Washington DC and southern Florida



World Data Center for Human Interactions in the Environment

10-m LECZ: New York City



Community District	
No.	Name
Manhattan	
101	Civic Center, Wall Street, Governors Island, Liberty Island, Ellis Island, Tribeca
102	Greenwich Village, Noho, Soho, Little Italy
103	Lower East Side, Chinatown, Two Bridges
104	Chelsea, Clinton
105	Midtown, Times Square, Herald Square, Midtown South
106	Murray Hill, East Midtown, Stuyvesant Town
107	Lincoln Square, Upper West Side
108	Upper East Side, Lenox Hill, Yorkville, Roosevelt Island
109	West Harlem, Morningside Heights, Manhattanville, Hamilton Heights
110	Central Harlem
111	East Harlem
112	Washington Heights, Inwood
164	Park
Bronx	
201	Mott Haven, Melrose, Port Morris
202	Hunts Point, Longwood
203	Melrose, Morrisania, Claremont, Crotona Park East
204	Highbridge, Concourse
205	Morris Heights, University Heights, Fordham, Mt. Hope
206	East Tremont, Bathgate, Belmont, West Farms
207	Kingsbridge Heights., Bedford Park, Fordham, University Heights
208	Kingsbridge, Riverdale, Marble Hill, Fieldston
209	Soundview, Castle Hill, Union Port, Parkchester
210	Throgs Neck, Pelham Bay, Co-op City, Westchester Square, City Island
211	Morris Park, Pelham Parkway, Bronxdale, Van Nest, Laconia
212	Williamsbridge, Baychester, Woodlawn, Wakefield, Eastchester
226	Park
227	Park
228	Park

Community District	
No.	Name
Brooklyn	
301	Greenpoint, Williamsburg
302	Downtown Brooklyn, Fort Greene, Brooklyn Heights, Boerum Hill
303	Bedford Stuyvesant, Tompkins Park North, Stuyvesant Heights
304	Bushwick
305	East New York, New Lots, City Line, Starrett City
306	Red Hook, Park Slope, Gowanus, Carroll Gardens, Cobble Hill
307	Sunset Park, Windsor Terrace
308	Crown Heights, Prospect Heights, Weeksville
309	Crown Heights South, Prospect Lefferts Gardens, Wingate
310	Bay Ridge, Dyker Heights, Fort Hamilton
311	Bensonhurst, Mapleton, Bath Beach, Gravesend
312	Borough Park, Ocean Parkway, Kensington
313	Coney Island, Brighton Beach, Gravesend, Homecrest, Seagate
314	Flatbush, Ocean Parkway, Midwood
315	Sheepshead Bay, Manhattan Beach, Kings Highway, Gravesend
316	Ocean Hill, Brownsville
317	Flatbush, Rugby, Farragut, Northeast Flatbush
318	Canarsie, Flatlands, Marine Park, Mill Basin, Bergen Beach
355	Park
356	Park
Staten Island	
501	North Island
502	Mid-Island
503	South Island
595	Park

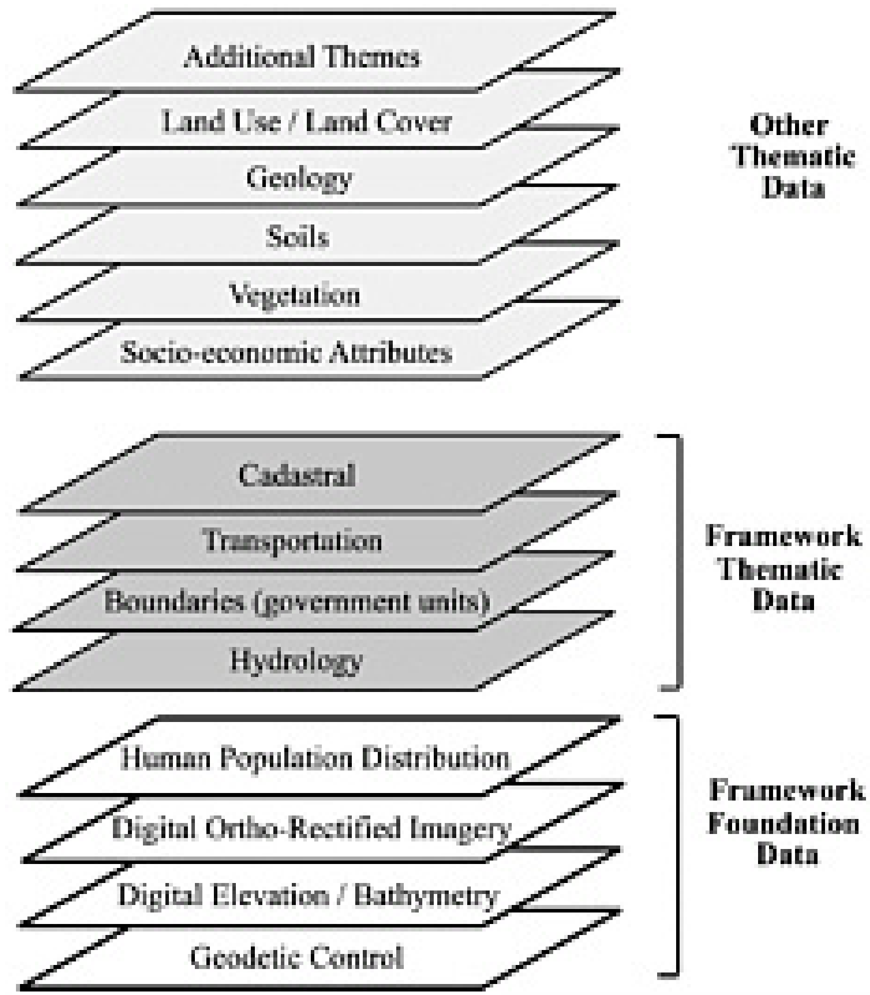
Community District	
No.	Name
Queens	
401	Astoria & Long Island City
402	Sunnyside & Woodside
403	Jackson Heights, East Elmhurst, North Corona
404	Elmhurst & Corona
405	Maspeth, Middle Village, Ridgewood, Glendale
406	Rego Park & Forest Hills
407	Flushing, Whitestone, College Point
408	Fresh Meadows, Kew Gardens Hills, Jamaica Hills
409	Woodhaven, Richmond Hill, Kew Gardens
410	Howard Beach, Ozone Park, South Ozone Park
411	Bayside, Douglaston, Little Neck, Auburndale
412	Jamaica, South Jamaica, Hollis, St. Albans
413	Laurelton, Cambria Heights, Queens Village, Glen Oaks
414	The Rockaways, Broad Channel
480	Airport
481	Park
482	Park
483	Airport
484	Park

CIESIN Columbia University

Units of Analysis Differ

World Data Center for Human Interactions in the Environment

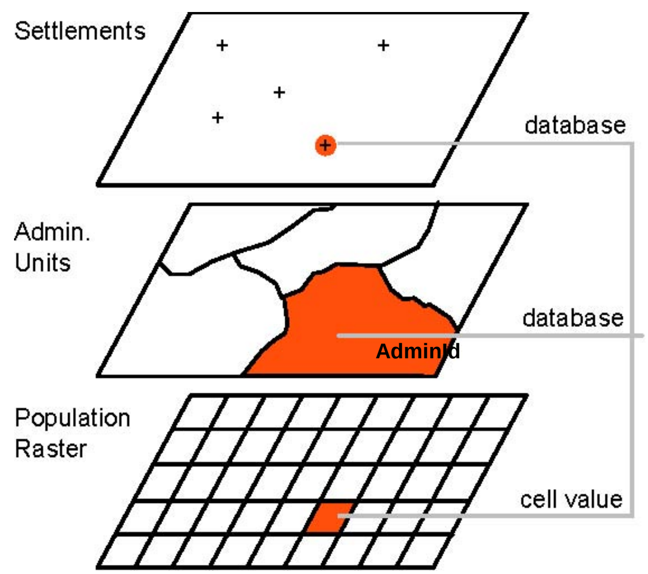
- Earth and social scientists use different units of analysis and have different ways of aggregating data
  - e.g., pixels vs. individuals, physical features vs. households, physiographic vs. administrative regions, grids vs. countries
- Linking such data requires conversion of data between geographies
  - e.g., grids to administrative units or vice versa



Converting Units of Analysis

World Data Center for Human Interactions in the Environment

- Administrative boundaries and population information in raster format.
  - Physio-geographic variables (climate, vegetation, soils) are frequently stored in raster format (Deichmann 1996).



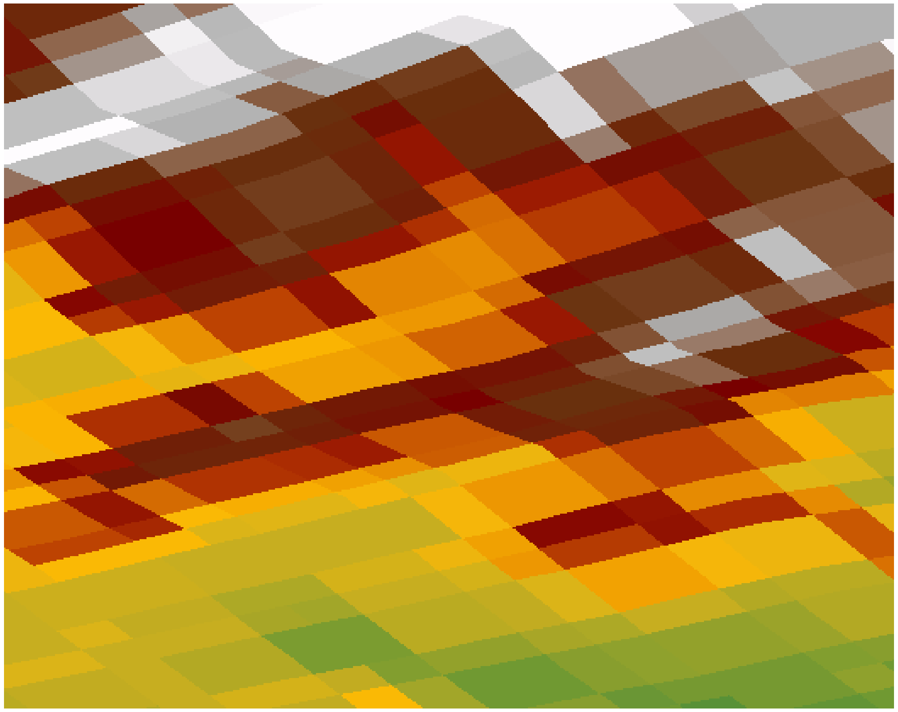
Source: Deichmann 1996: 24

Need access to data before it can be integrated

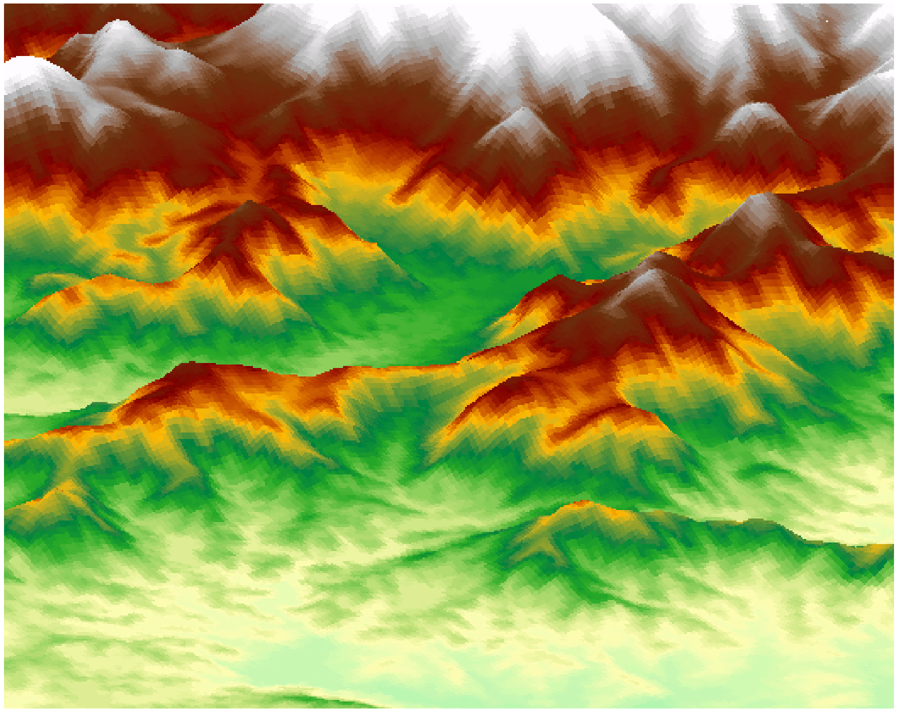
World Data Center for Human Interactions in the Environment

- Increased concerns about national security, intellectual property rights leading to reduced access to data
- Example: U.S. has not released 30-m SRTM for world, despite significant potential benefit for applications
  - Comparison of 30- and 90-m SRTM for Blue Ridge Mountains, VA:

90 m



30 m

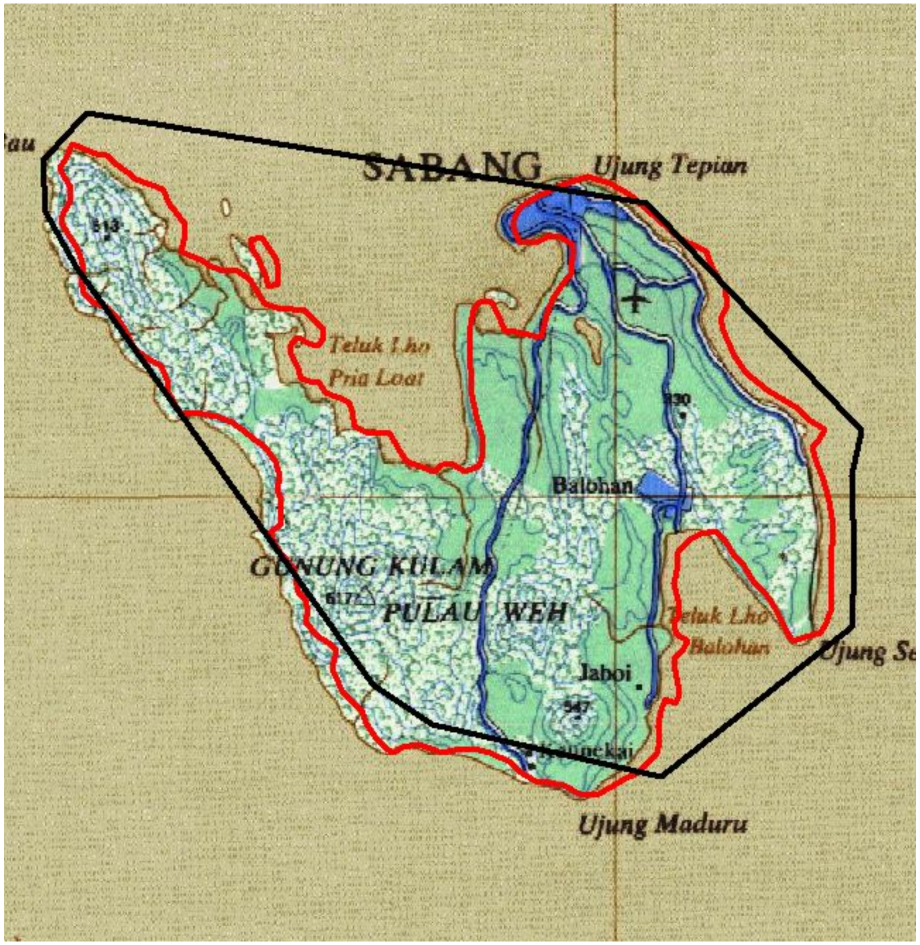


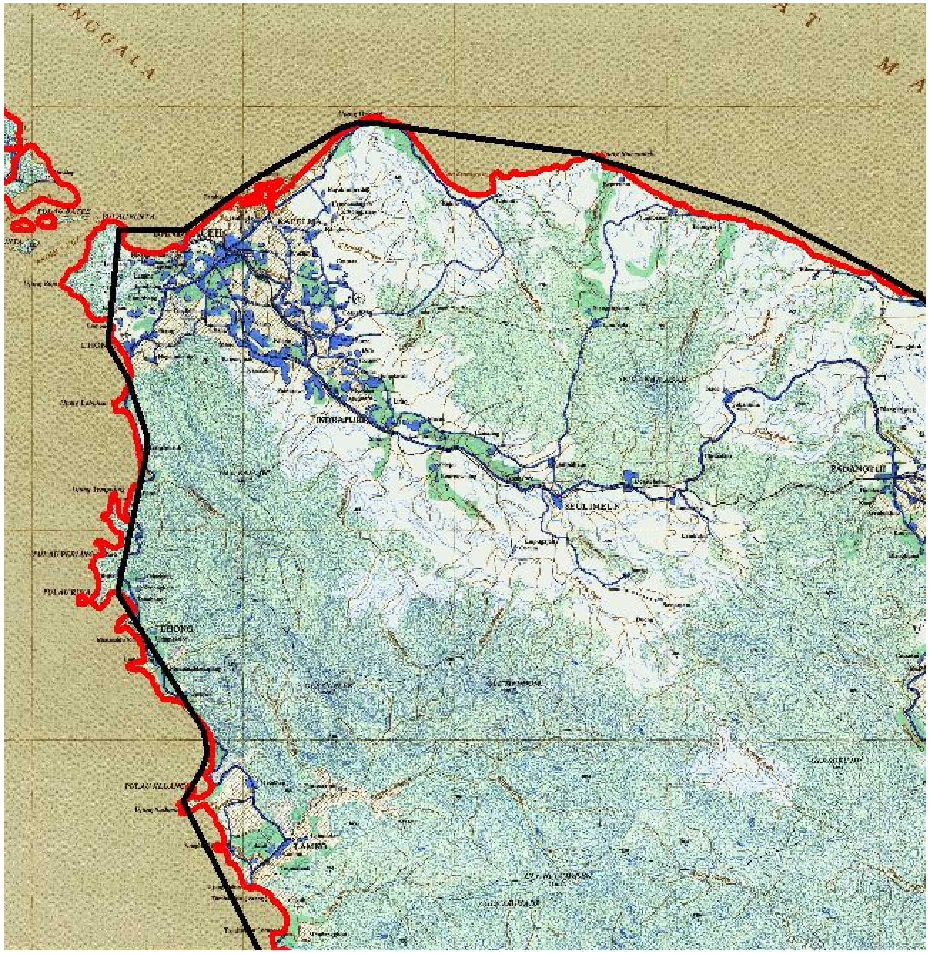
Comparison courtesy of Y. Gorokhovich, CIESIN

Conflicting boundary data

CIESIN
Columbia University

WDC
World Data Center for Human Interactions in the Environment





Black shoreline: ESRI

Red shoreline: Administrative Units, BPS

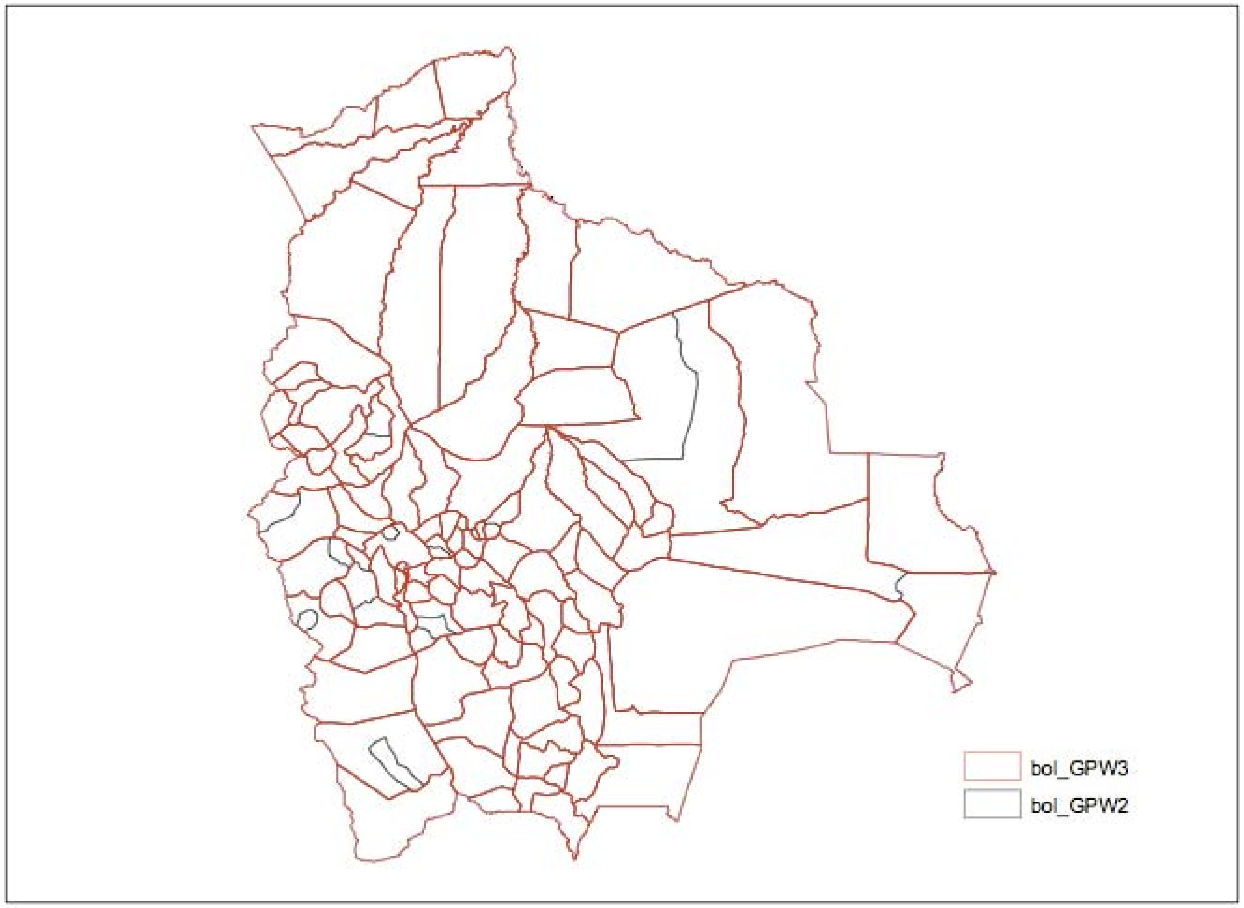
Challenge 2

World Data Center for Human Interactions in the Environment

- Inter-annual change in the spatial distribution of population is almost impossible to characterize with precision, because of incommensurate administrative boundaries across censuses.

BOLIVIA: Change in boundaries between censuses

World Data Center for Human Interactions in the Environment



Challenge 2, cont.

- Tracking changes in the spatial framework permits comparisons over time
- Changes in census spatial units are more common at higher resolution (census tract level and higher)
- These higher level resolutions are the ones needed for vulnerability assessment

Challenge 3

- Intra-annual variation in population distribution is not systematically tracked, making it hard to characterize exposure to highly variable climate risks

Recommendations

- Greater spatial precision in census units (boundary data)
- Commitment to "spatial backcasting" when census units are redrawn, to permit spatial census time series (which are now impossible)
- Discourage redrawing census units unless necessary
- Use of surveys to pinpoint inter- and intra-annual population movement

Recommendations, cont.

World Data Center for Human Interactions in the Environment

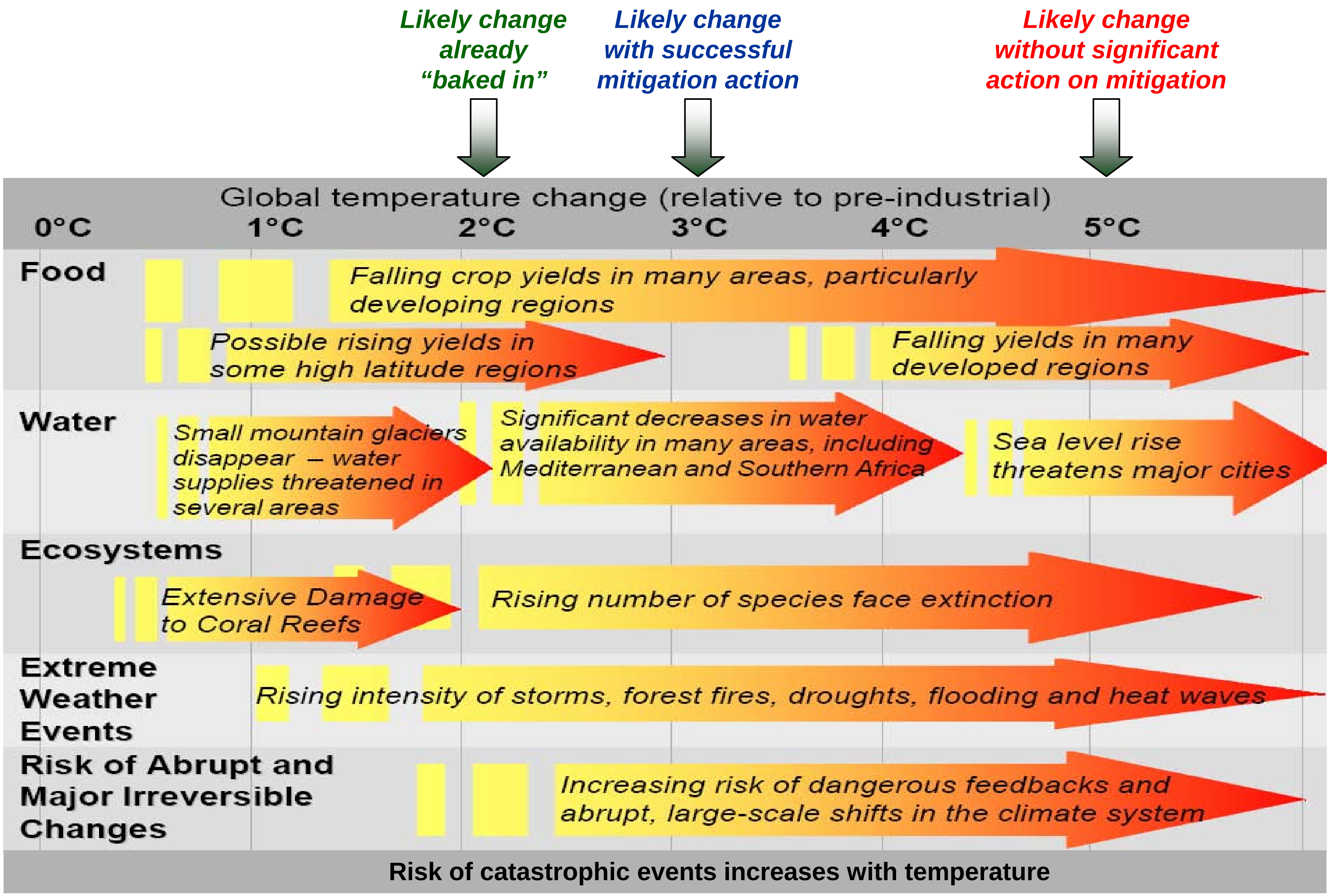
- Capture information about place of work, daily displacements including shopping and schools, seasonal movements, etc. in surveys/other ways(?)
- More attention to spatial mobility, including migration

Planning adaptation responses: data needs

Kseniya Lvovsky
Program Leader, Climate Change

UN Conference on Climate Change and Official Statistics
Oslo (Norway) 14-16 April 2008

Adaptation to what? Likely impacts…



Source: **Adapted from IPCC 2007.**

Six Climate Threats

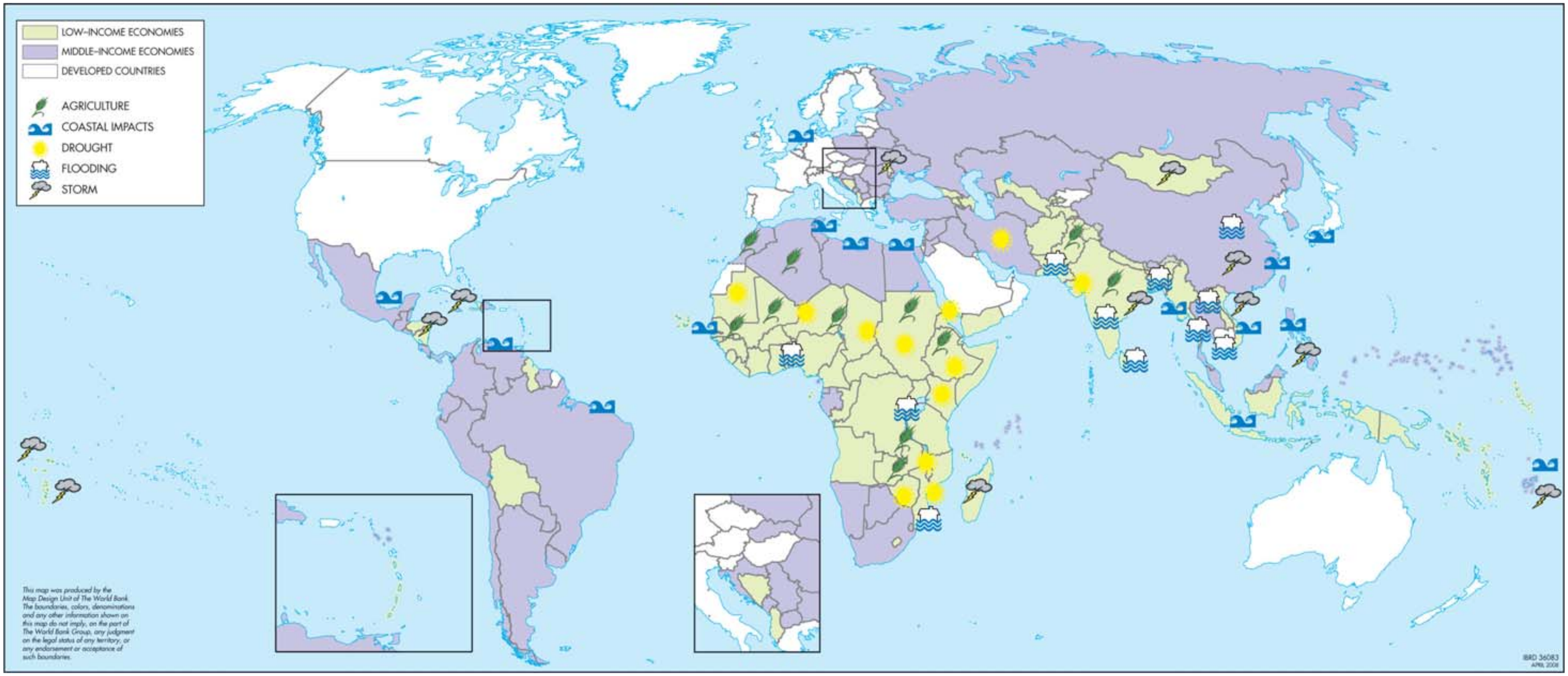
Top 12 Countries Most at Risk from Each

Low Income | Middle Income | High Income

Drought	*Flood*	*Storm*	*Coastal 1m*	*Coastal 5m*	*Agriculture*
Malawi	Bangladesh	Philippines	All low-lying Island States	All low-lying Island States	Sudan
Ethiopia	China	Bangladesh	Vietnam	Netherlands	Senegal
Zimbabwe	India	Madagascar	Egypt	Japan	Zimbabwe
India	Cambodia	Vietnam	Tunisia	Bangladesh	Mali
Mozambique	Mozambique	Moldova	Indonesia	Philippines	Zambia
Niger	Laos	Mongolia	Mauritania	Egypt	Morocco
Mauritania	Pakistan	Haiti	China	Brazil	Niger
Eritrea	Sri Lanka	Samoa	Mexico	Venezuela	India
Sudan	Thailand	Tonga	Myanmar	Senegal	Malawi
Chad	Vietnam	China	Bangladesh	Fiji	Algeria
Kenya	Benin	Honduras	Senegal	Vietnam	Ethiopia
Iran	Rwanda	Fiji	Libya	Denmark	Pakistan

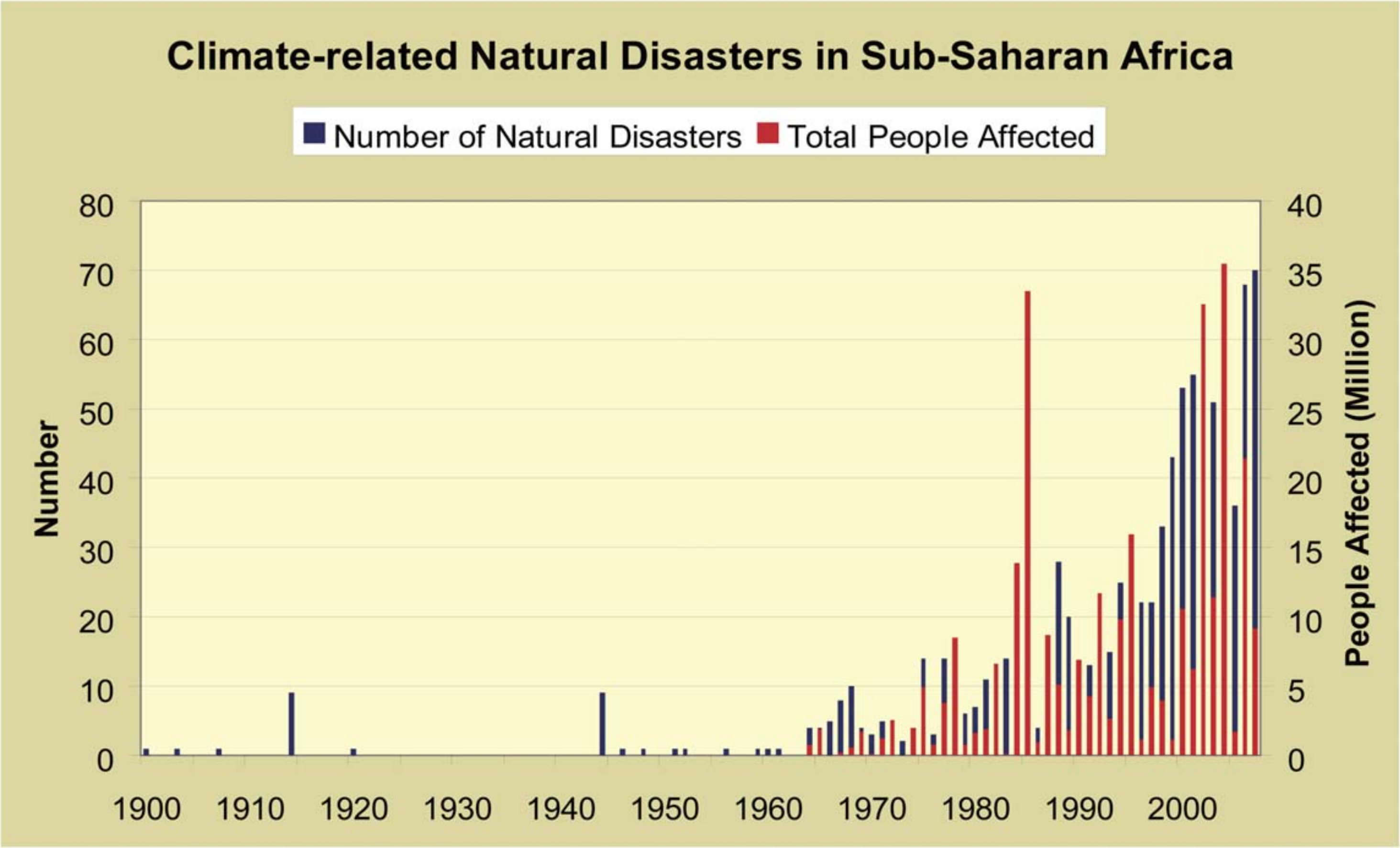
Source: **World Bank staff.**

Adaptation is particularly important for poor countries where climate risks are higher…

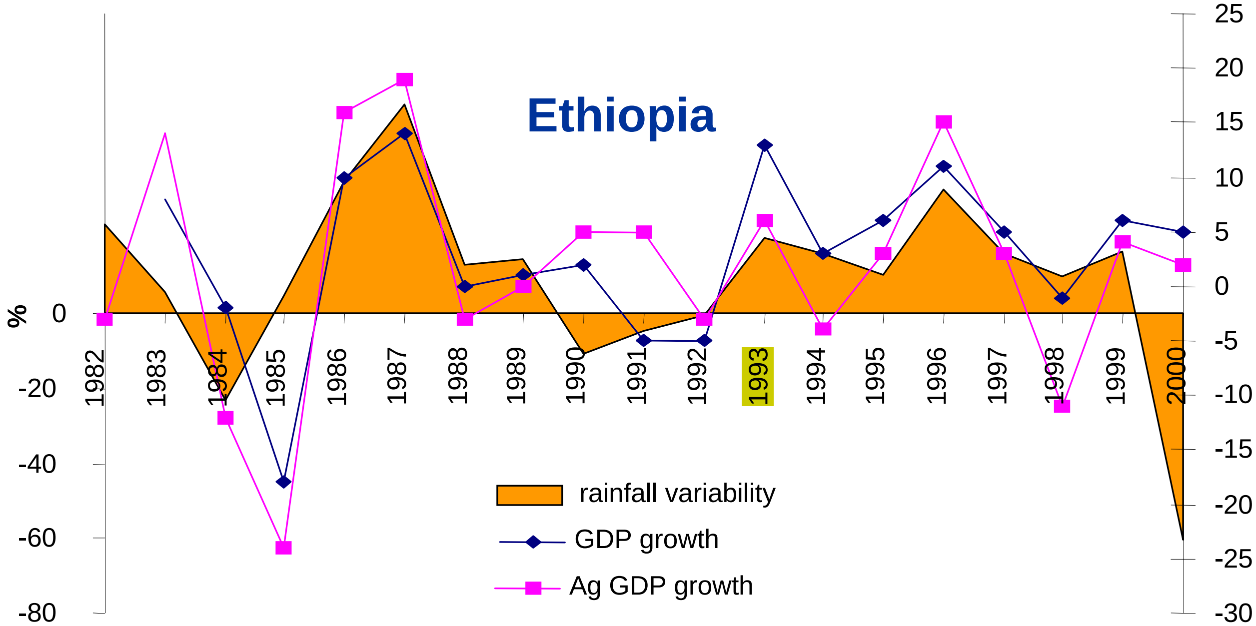


Source: **World Bank staff.**

Adaptation is today's priority: number and impact of natural disasters are both increasing…

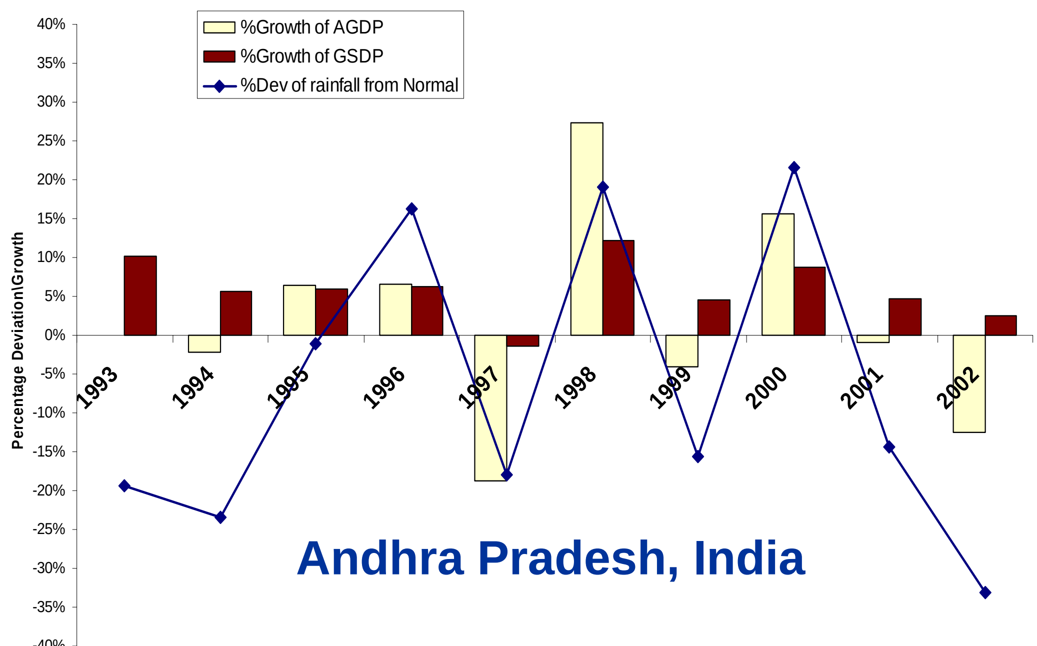


Source: **Centre for the Research on the Epidemiology of Disasters, Universite Catholique de Louvain. www.emdat.eb Disasters include floods, droughts, landslides, extreme temperature events, wind storms, wave/storm surges and wildfires.**



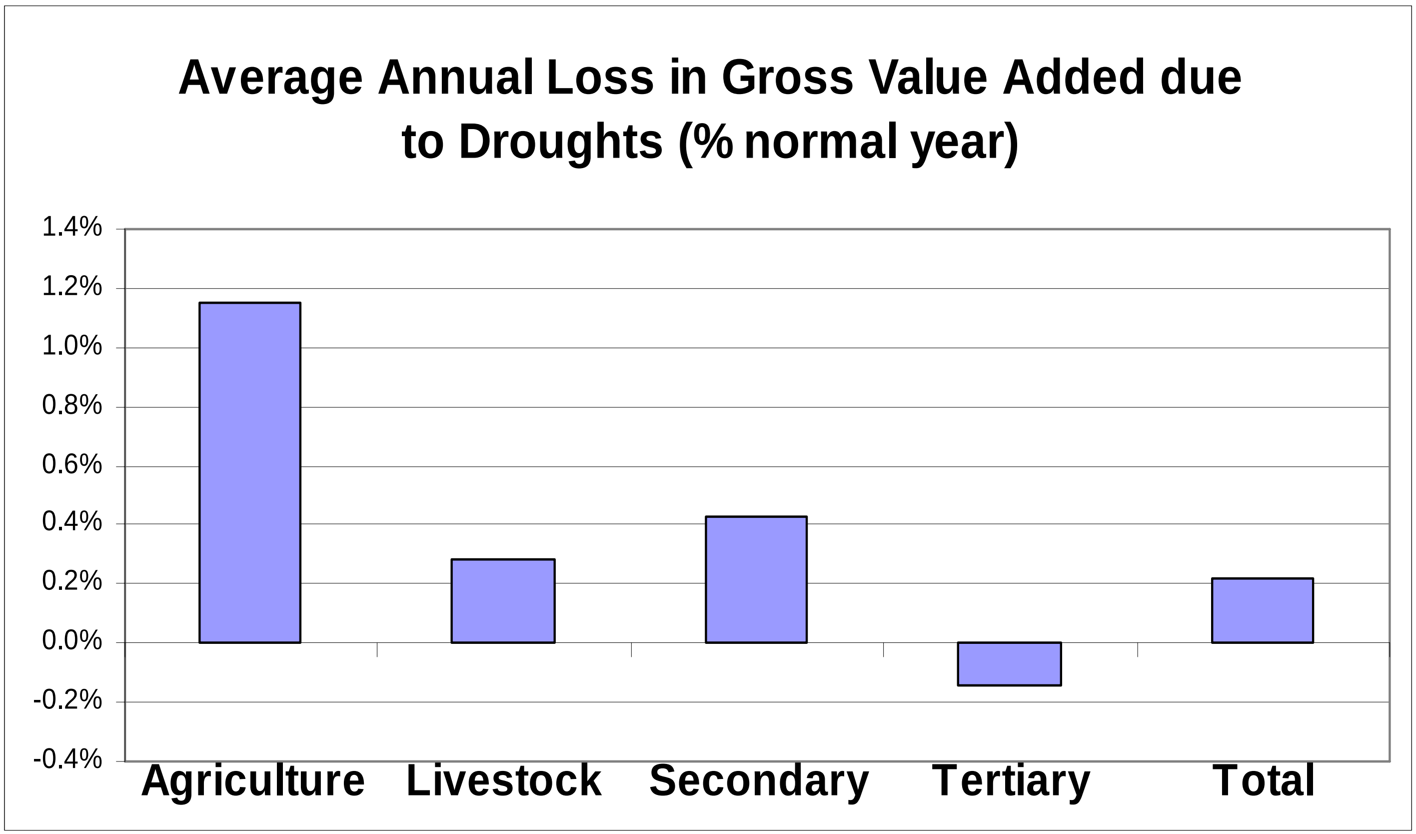
Source: World Bank

And affects economic performance:
GDP growth follows rainfall in agriculture-dependent economies



Economic impact of drought is highest in agriculture, with the least impact on services

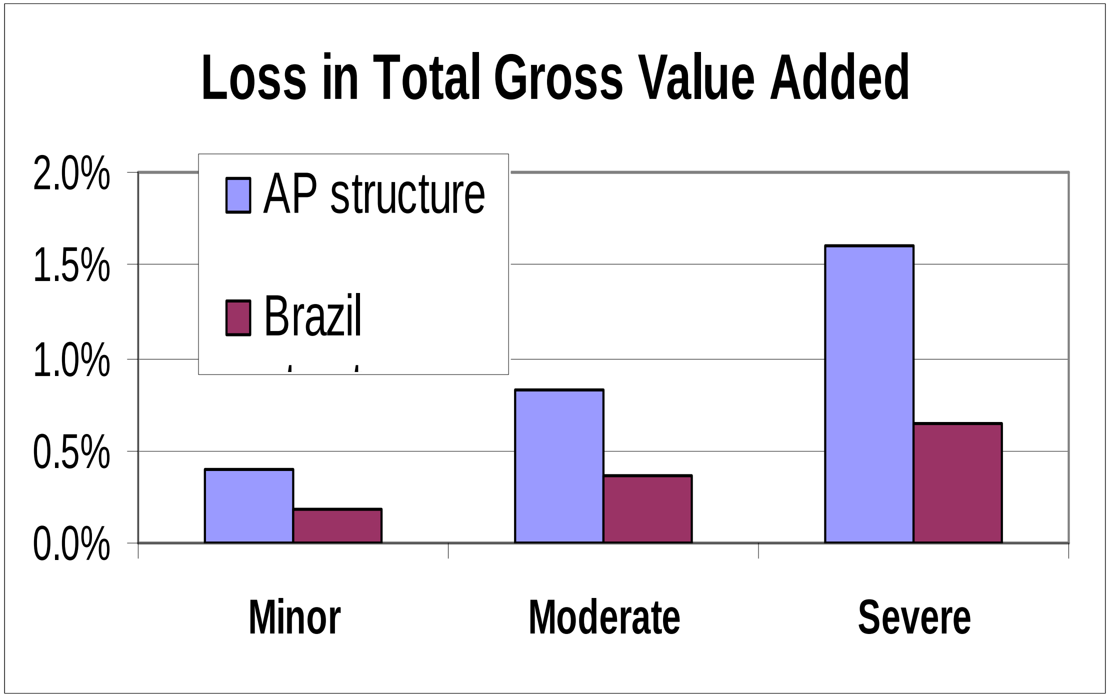
Andhra Pradesh, India



Source: World Bank

Overall economic impact will further decline due to a structural shift towards service sectors

- Scenario 1 – GVA Loss due to drought under the current structure of the AP economy:
  - GVA in agriculture – 20%
  - GVA in Services – 50%
- Scenario 2 - GVA Loss due to same drought risks under the structure similar to that of Brazil:
  - GVA in agriculture – 10%
  - GVA in services – 65%

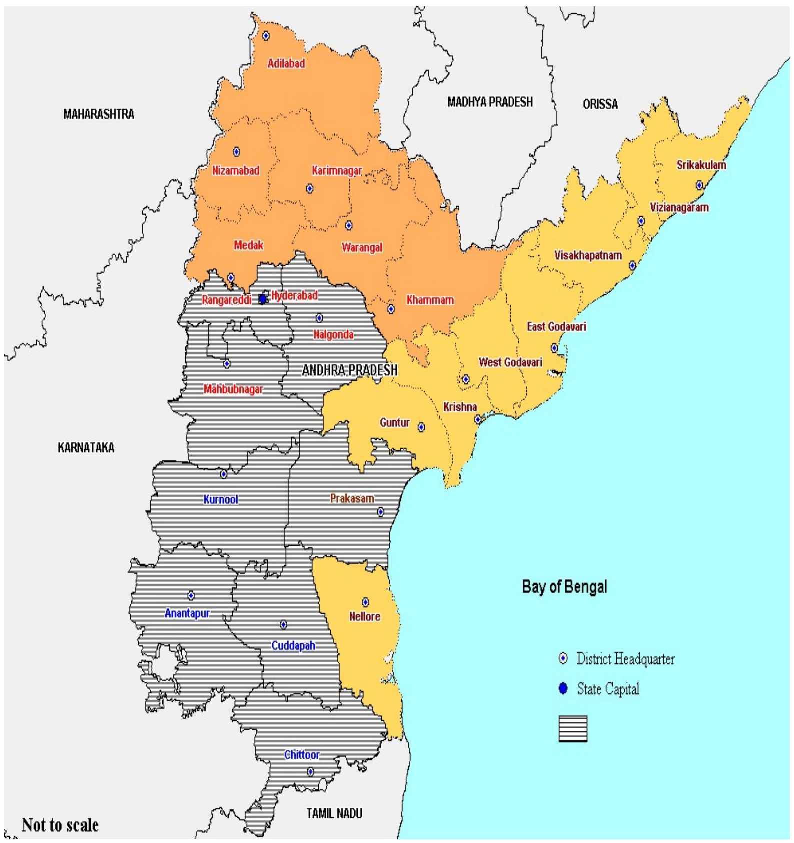


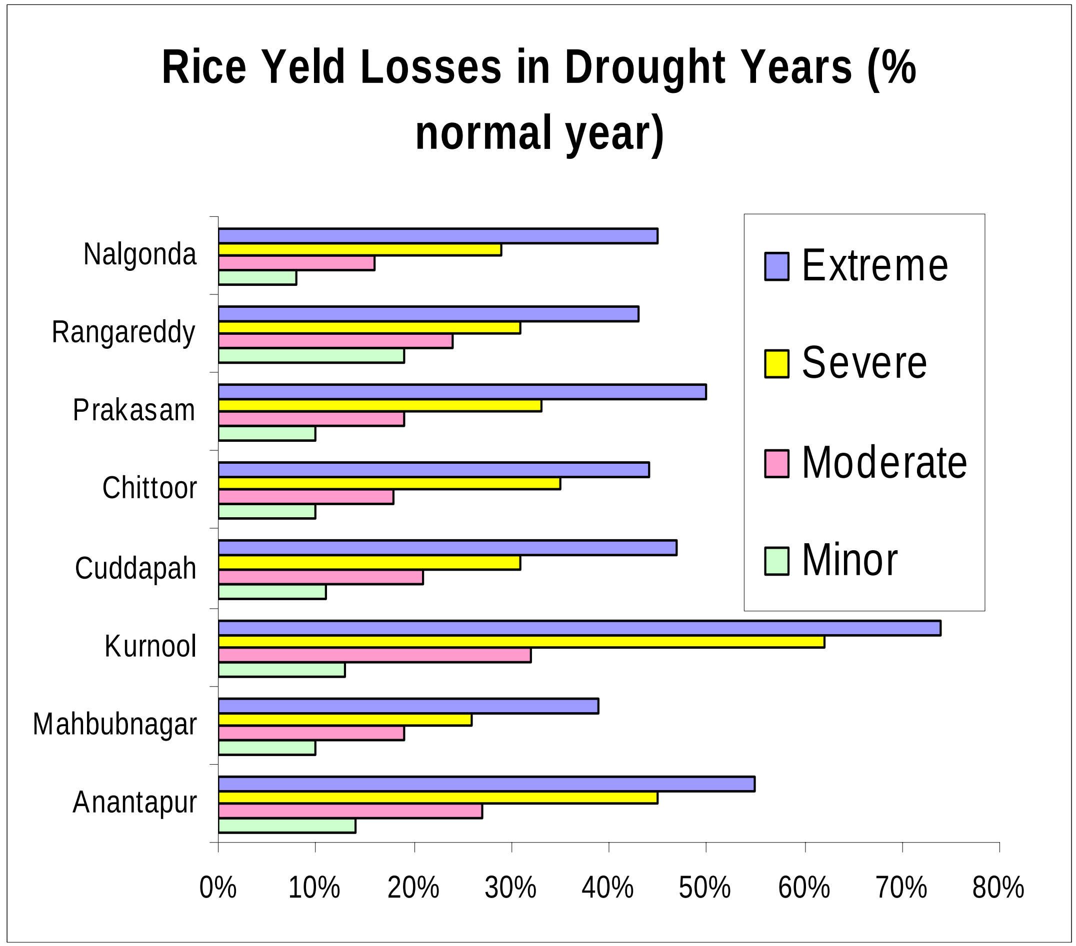
Source: World Bank

But disparities remain and may increase

- Population dependent on agriculture remains significant
- Loss of employment remains key concern
  - The total employment loss due to 2002 drought was over 4 million
- Individual farmers and communities continue suffering severe losses and falling into poverty
- Adaptation needs and strategies are local: need strong local institutions and targeted, customized support programs to those in need

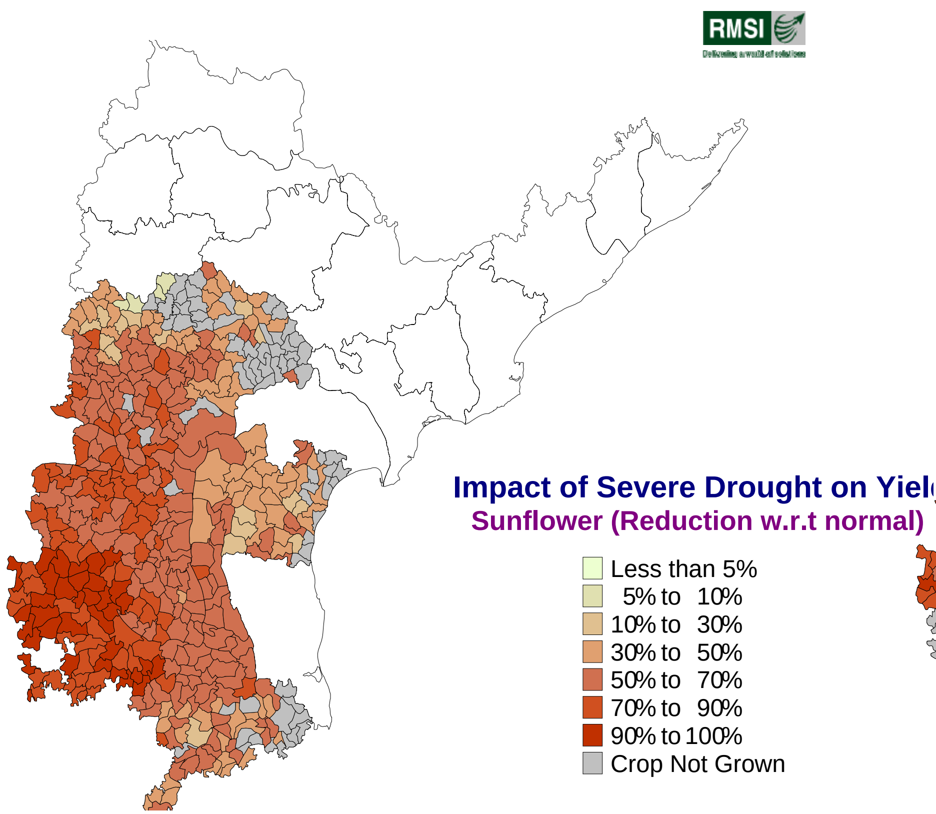
Impacts are highly variable by location, crop and drought severity: drought-prone districts in AP, India



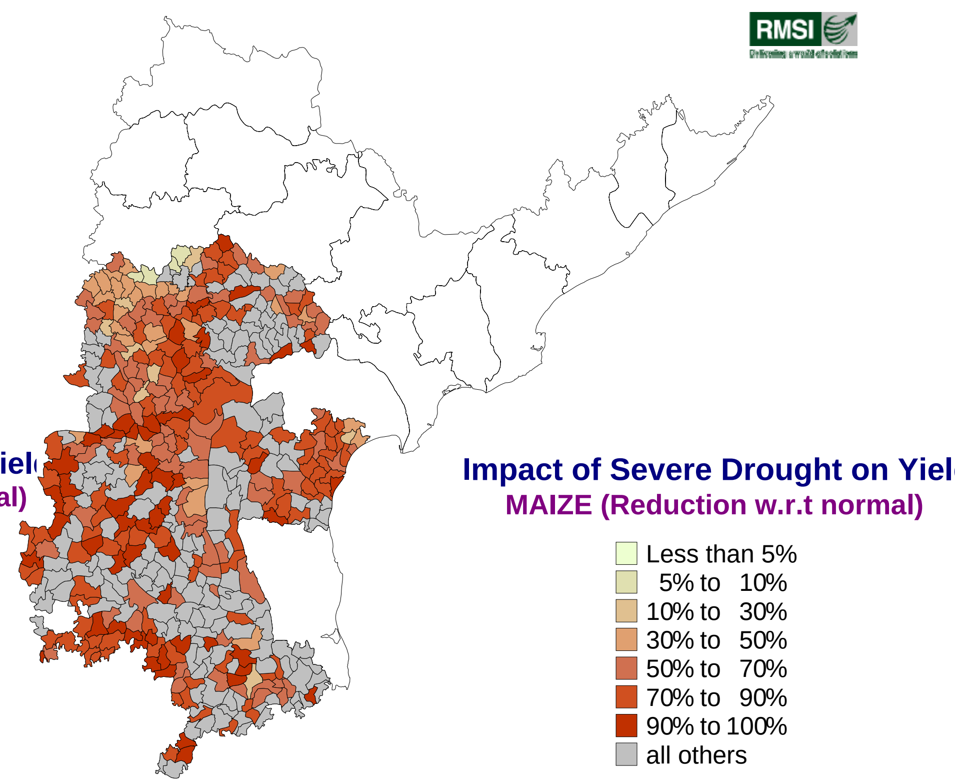


Impacts are highly variable by location, crop and drought severity: mandal level; AP, India

Sunflower yields

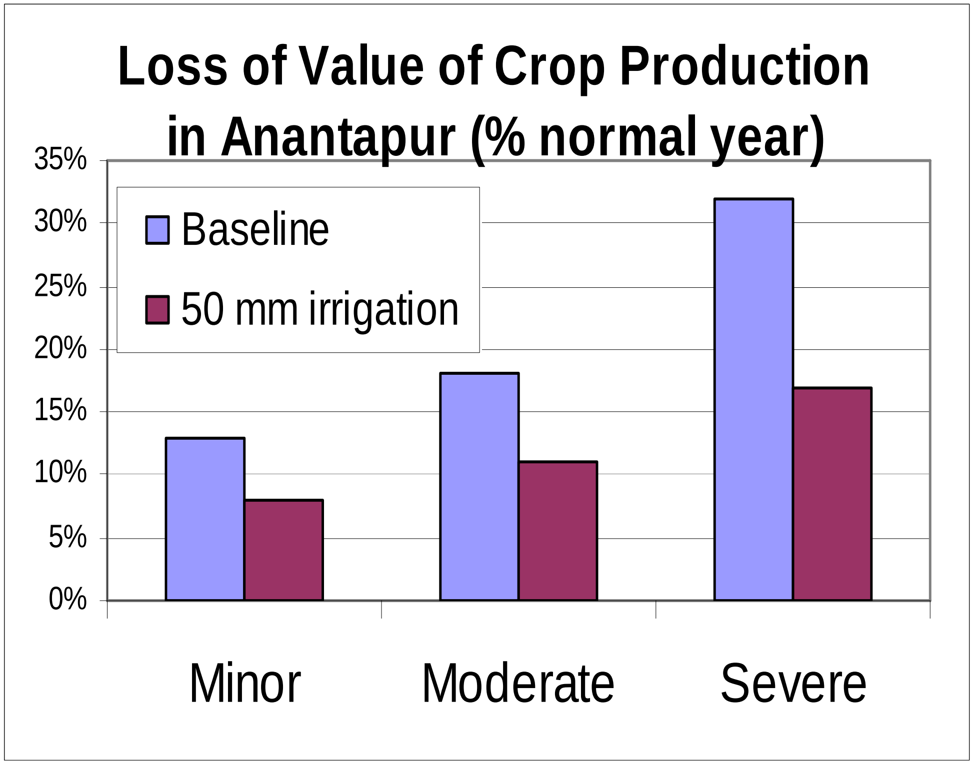


Maize yields



Effective coping strategies are location-specific
Analysis of adaptation responses in AP, India

- Coping (adaptation) strategy:
  - *Permanently* reduce rice area and use surplus water for irrigating less water intensive crops
- Effective for Anantapur
  - Increases crop production value by one/ third
  - Reduces losses by half in drought years
- But limited scope in Mahabubnagar



Source: World Bank

Data Needs for Climate Change Adaptation (1)

- **Meteorological Data**

➢ First priority: digitization of historical records

➢ Breadth over depth: more weather stations collecting basic data -> rainfall variability often more important than mean

➢ Improved seasonal forecasting (e.g. droughts)

➢ Need long consistent time series – start now

- **Natural Disaster Data**

➢ Better understanding of spatial extent and duration

➢ Better estimates of impacts and costs

➢ Mitigating/exacerbating factors

Data Needs for Climate Change Adaptation (2)

- **Agricultural Data**
  - Spatially-varying data on crop yields, soil degradation; groundwater recharge and drawdown
  - Coping strategies (diversification), cultivars and varieties (e.g. drought resistant), soil/water/crop mgt practices, etc.
- **Water Management Data**
  - Spatiotemporal distribution of river discharge/hydrology
  - Water demand and scarcity
- **Ecosystems**
  - Baselines of biodiversity, species ranges and ecosystem function; spread of invasive species; rate of deforestation
- **Health**
  - Changes in incidence of climate-related vector-borne diseases and shifts in vectors' ranges

Data Needs for Climate Change Adaptation (3)

- **Climate Change Projections**

➢ Global Circulation Model data: Utilize model outputs: mean changes but also climate extremes for the region

➢ Need to understand where models agree and performance of GCMs for the area

➢ Downscaling climate projections (Regional Climate Models, statistical techniques)

– But depends on question and use (e.g. impact modeling for water resources)

- In general, dearth of downscaling for critical areas in developing world, e.g. Africa

Data Needs for Climate Change Adaptation (4)

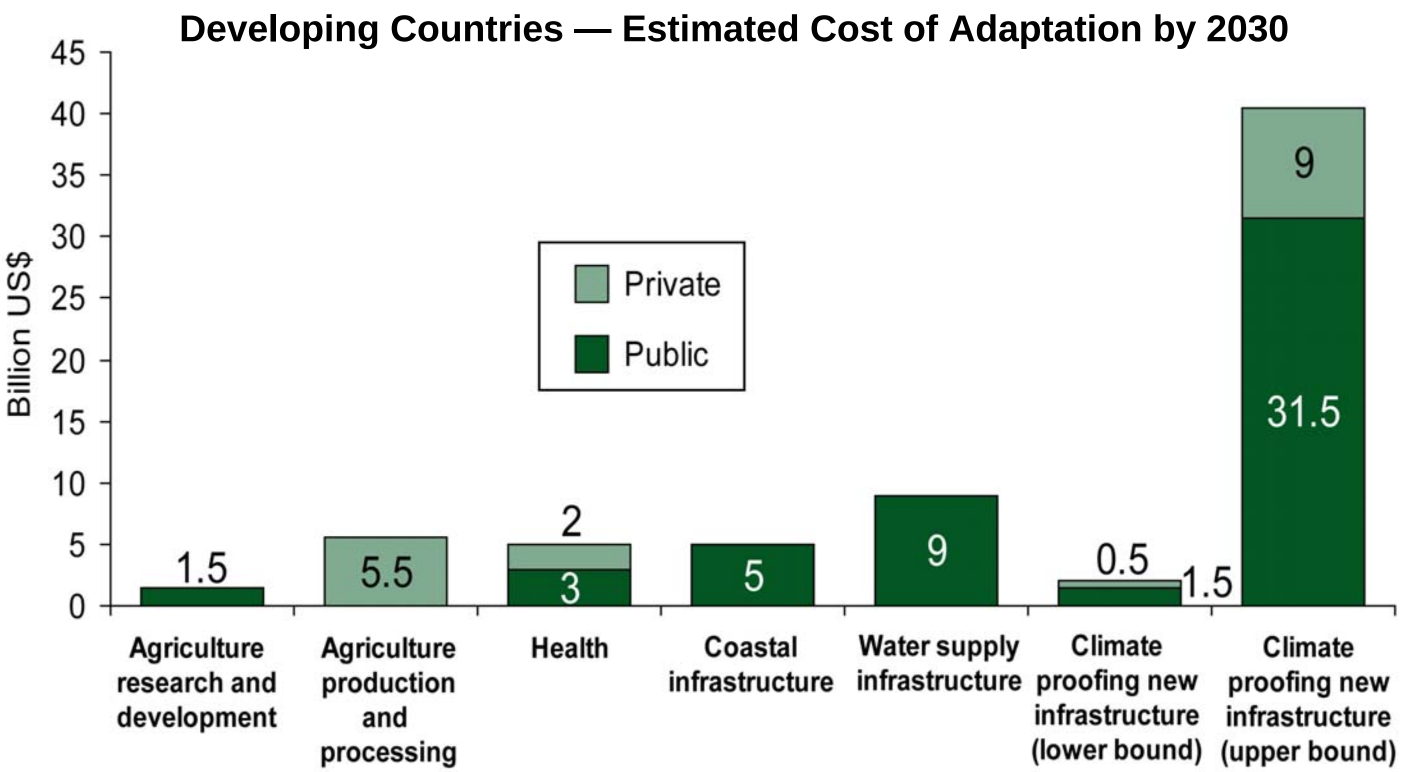
- **Economic data**
  - Economic losses form impacts
  - Costs of actions that reduce/avoid losses:
    - ✓ Investment costs, economic costs (and benefits)
    - ✓ By sector and location
    - ✓ By technology and type of infrastructure
    - ✓ At different level- country, local government, community, household
  - Instruments: technical estimates, surveys (spatial referencing consistent with physical data important), I/O and macro-models
- **Policies and institutions**
  - Subsidies (water, crops), disaster management programs, insurance schemes, micro-finance, etc.
  - Coordination mechanisms, particularly at the local level; planning processes, extension services, availability of weather and marketing information

How Much Does Adaptation Cost?

There Are Some Estimates, but the Ranges Are Wide and Uncertain

- The implied change in temperature is 1.5º C for 2030

- Cost estimates based on expert opinion



Source: UNFCCC 2007.

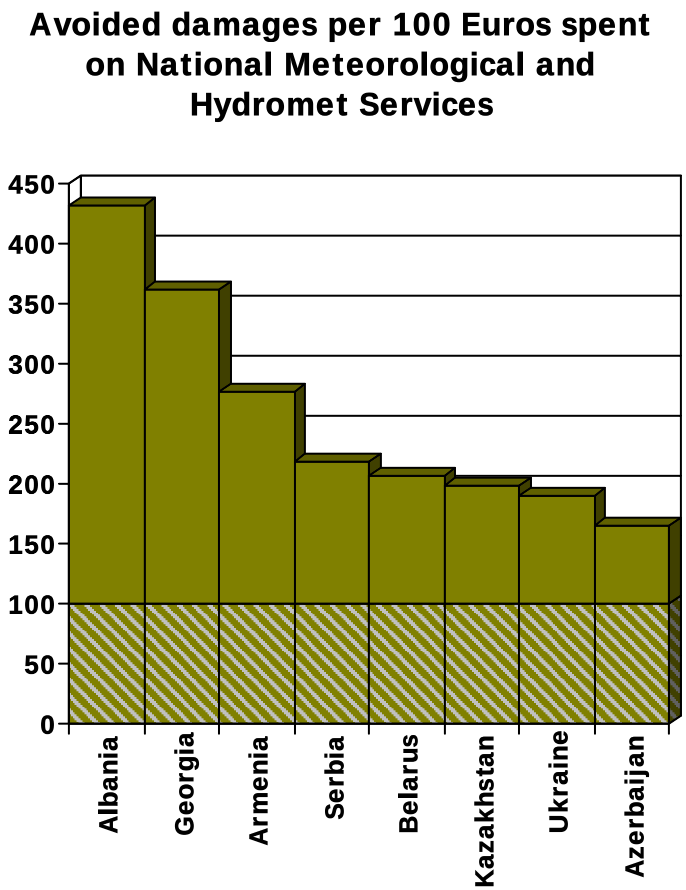
Key messages

- **Large data needs: important to prioritize and use resources effectively**
  - Spatially disaggregated and referenced data
  - Level of complexity should match capacity to collect, analyze and maintain over long time periods
  - Complex data good; simple, reliable and consistent better
  - Easy to aggregate and link to other datasets
- **Build on existing instruments and capacity:**
  - Hydro-metrological service
    - more stations collecting basic data
  - Household and institutional surveys
    - Special referencing linked to hydro-met data, select additional questions
  - Economic statistics and modeling
- **Coordination** in collection, analysis and use of data across agencies

How can World Bank help?

- *IDA and Climate Change Paper*
  - A case for integrating adaptation in IDA-supported programs
- Global Economics of Adaptation study
  - Developing country case studies
  - Methodologies, estimates, capacity needs
- Country, regional and sectoral analyses
- Pilot adaptation programs: building knowledge, capacity, institutional and investment models
- Climate risk insurance products
- Hydromet services strengthening projects
- Proposed Pilot Climate Resilience Program
  - Integrating adaptation in development planning

Good News: Smart investment in Adaptation-relevant Data is Cost-Effective



- Each 100 Euros spent in meteorological systems yields at least 200 Euros in avoided damages

THANK YOU!

Measuring the Impacts of Climate Change

Are Central Statistical Offices Prepared?

Conference on Climate Change and Official Statistcs
Oslo, Norway
14-16 April 2008

Robert Smith
Statistics Canada

Overview

- Quick look at climate change and its impacts
- Statistical infrastructure – What is needed?
  - Frameworks
  - Knowledge
- Data – What is needed?

Climate change impacts

- Biophysical
  - warming; changes in precipitation patterns; disappearance of ice; changes in habitat
- Social
  - health; loss of cultural traditions; forced migration
- Economic
  - Farming, fishing, logging; energy use; transportation; infrastructure; prices

Statistical Infrastructure Needs

Frameworks – What is needed?

- Frameworks – the tools that give structure to statistics
  - Conceptual
    - Define *what* to measure and *why*
  - Measurement
    - Define *how* to measure
  - Classifications
    - Bring order to what would otherwise be chaos

Conceptual framework

- Can the existing framework of economic development serve as a framework for measuring climate change impacts?
  - Yes, if suitably broadened
- Climate change impacts are long-term
  - Capital framework is best suited to long-term issues

Capital as a framework

- Standard capital framework must be broadened
  – Most importantly, to include natural capital
  – Recognizing human and social capital also important
- The good news is that much of the thinking has already been done
  – Rich academic literature
  – Joint ECE/OECD/Eurostat Working Group on Statistics for Sustainable Development preparing a report for June 2008

Measurement framework

- A framework compatible with the *System of National Accounts* is needed
  - Understanding climate change impacts requires linkage of environmental, economic and social data

- UN *System of Environment and Economic Accounts* (SEEA) is very close to what is needed
  - A rigorous framework for organizing environmental stock and flow data
  - Treatment of ecosystem assets is the main weakness in SEEA at the moment
  - Social concerns also not covered, but could be

Classifications

- Many existing classifications are relevant
  - industries, products, census regions
- Also needed are
  - ecological classifications
  - land cover and land use classifications
  - drainage basin classifications
  - waste classifications
  - classifications of ecosystem services
- Climate change impacts will be spatially differentiated
  - therefore, spatial classifications are key for analysis

Knowledge – What is needed?

- Climate change will affect environment, economy and society
  - CSOs well placed on economy and society, but less so on environment

- Building capacity to work on environmental issues a major challenge

Building environmental knowledge

- First, the right people needed to attracted
  - CSOs need to make it better known that they do exciting work on environmental issues
  - Environmental specialists need to be convinced that they will not be "on the margins" if they join a CSO
    - And they need to be made to feel part of the mainstream when they join

Building environmental knowledge

- Second, once hired, environmental specialists need to be trained
  - Existing training programs on surveys, statistical methods, national accounts, *etc.* necessary, but not sufficient
  - Additional training on environmental issues required
    - Best done outside the CSO?

Building environmental knowledge

- Third, thinning of environmental expertise is a real risk
  - Environment statistics are very broad and expertise within CSOs is (and will be) limited
    - Some issues will be left untreated
    - Some issues will get treated superficially
    - Progress in expanding the coverage of environmental issues will be slow
  - Best strategy to focus on selected high-priority issues and leave the rest until the program can grow

Data needs

Data to address climate change impacts

- Economic and social data reasonably complete
  - Health data may be an exception

- Environmental data are where the gaps are mainly found, including
  - Land use and land cover
  - Water use and availability
  - Air quality
  - Forest inventories

Thoughts on building environmental data

1. Choose a clear and robust conceptual framework to guide data collection
   - Avoids *ad hoc* collection
2. Build an environmental survey program tightly linked to environmental accounts
   - The success of the SNA is a good model
3. Build good relations with other departments and make use of their administrative and scientific data
4. Integrate environment statistics into statistical mainstream
   - Adhere to standards; use corporate collection infrastructure; apply accepted concepts and methods
5. Build a spatial analysis capacity and collect data that can exploit its potential
   - Cannot measure climate change impacts except spatially

Thank you

Robert Smith
Director, Environment Accounts and Statistics
Statistics Canada
robert.b.smith@statcan.ca
613-951-2810

Session Three: The Analytical Usefulness of a System of Environmental Accounts

Peter van de Ven
Statistics Netherlands

S.O.S.

S.O.S.

A <u>S</u>tandard for <u>O</u>fficial <u>S</u>tatistics

=>

Elevation of the SEEA

Standard set of tables

The way forward (1)

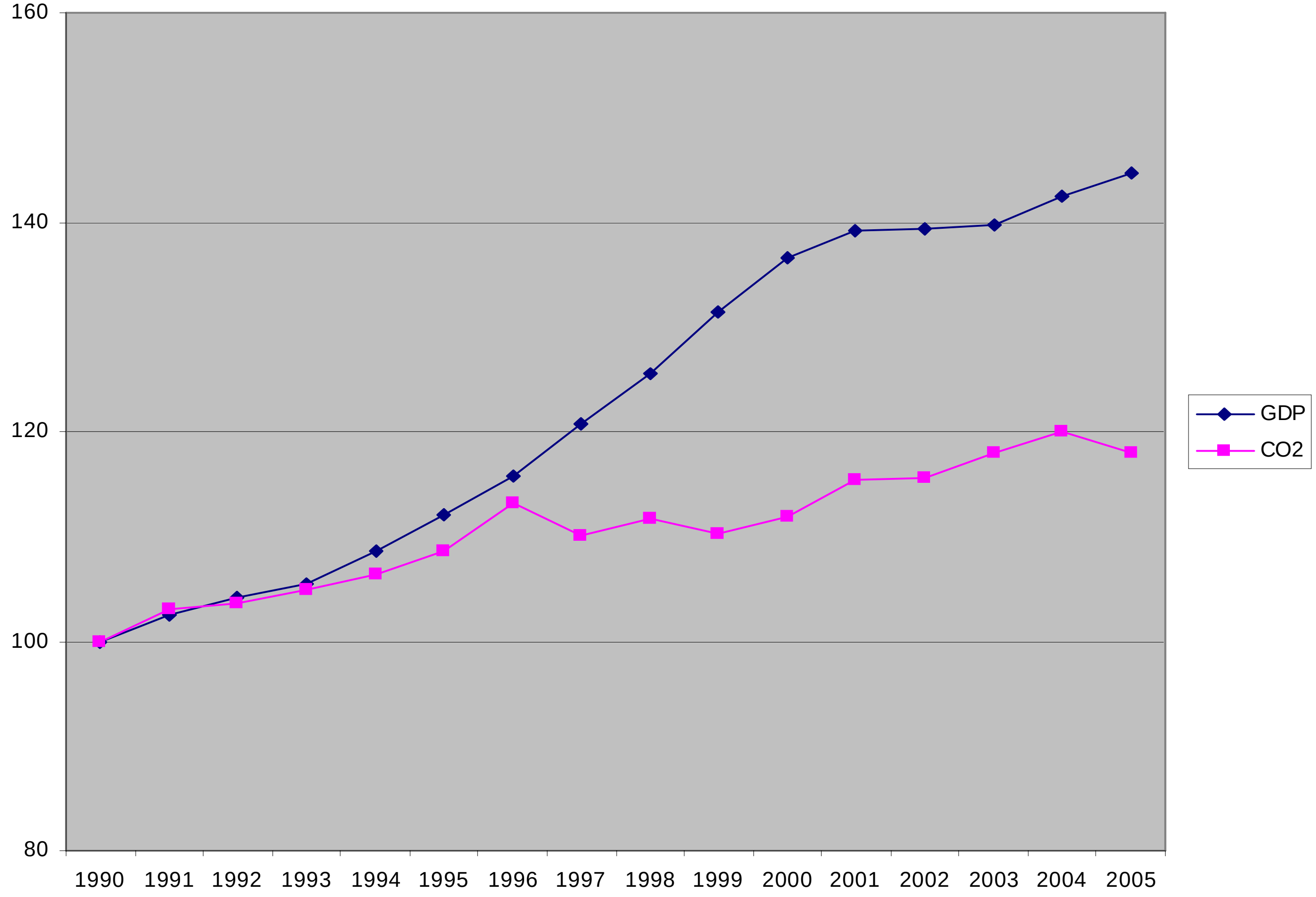
- Much discussion on valuation issues (e.g. degradation of ecosystems)
- Not solvable in the near future
- Push the agenda on the issues we can agree upon
- SEEA, Volume I

The way forward (2)

- A set of indicators on (macro-) economic and environmental issues
  - measured in observable units
  - in an integrated framework

- Very powerful tool for analysis and modelling
- Some examples from the NL-practice

GDP-growth and CO2-emissions, 1990-2005

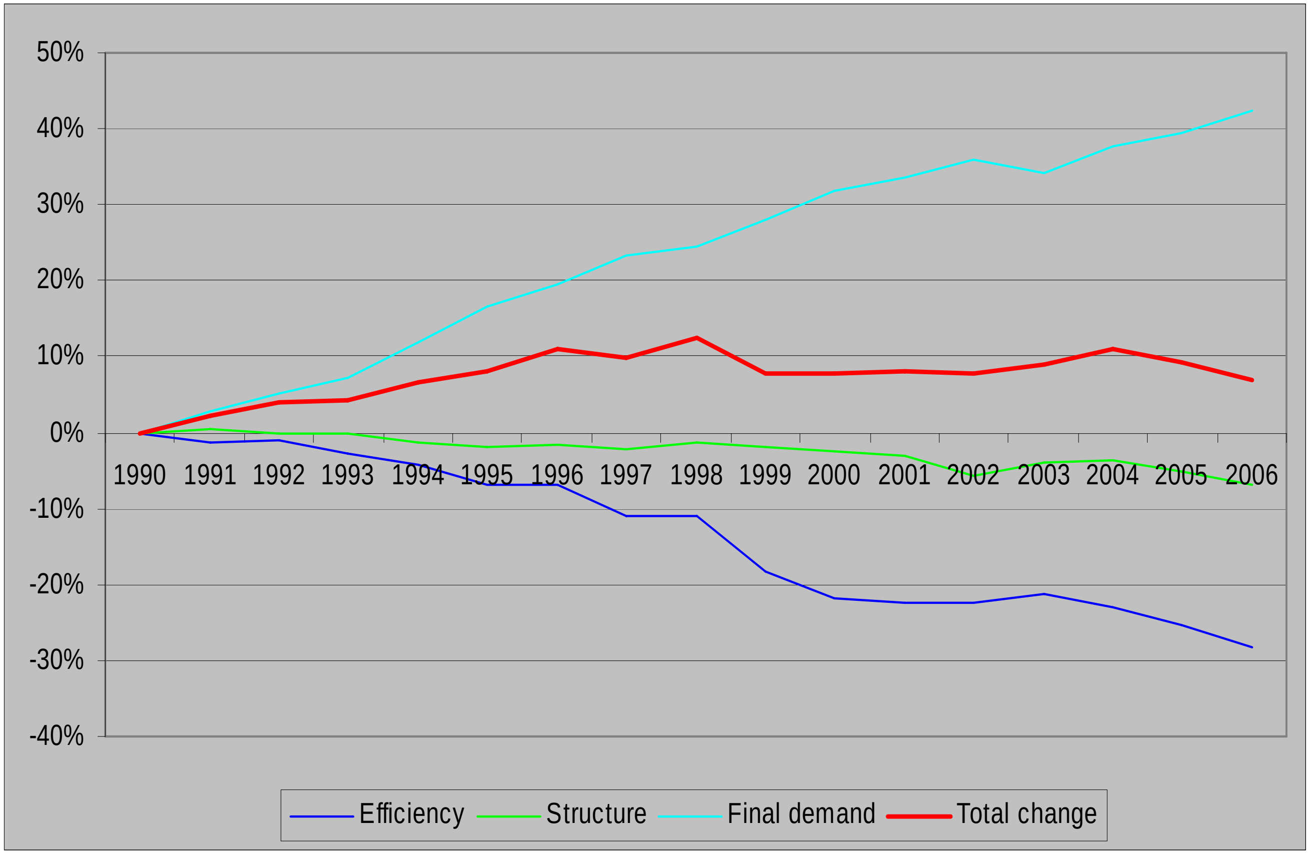


National accounts, key figures

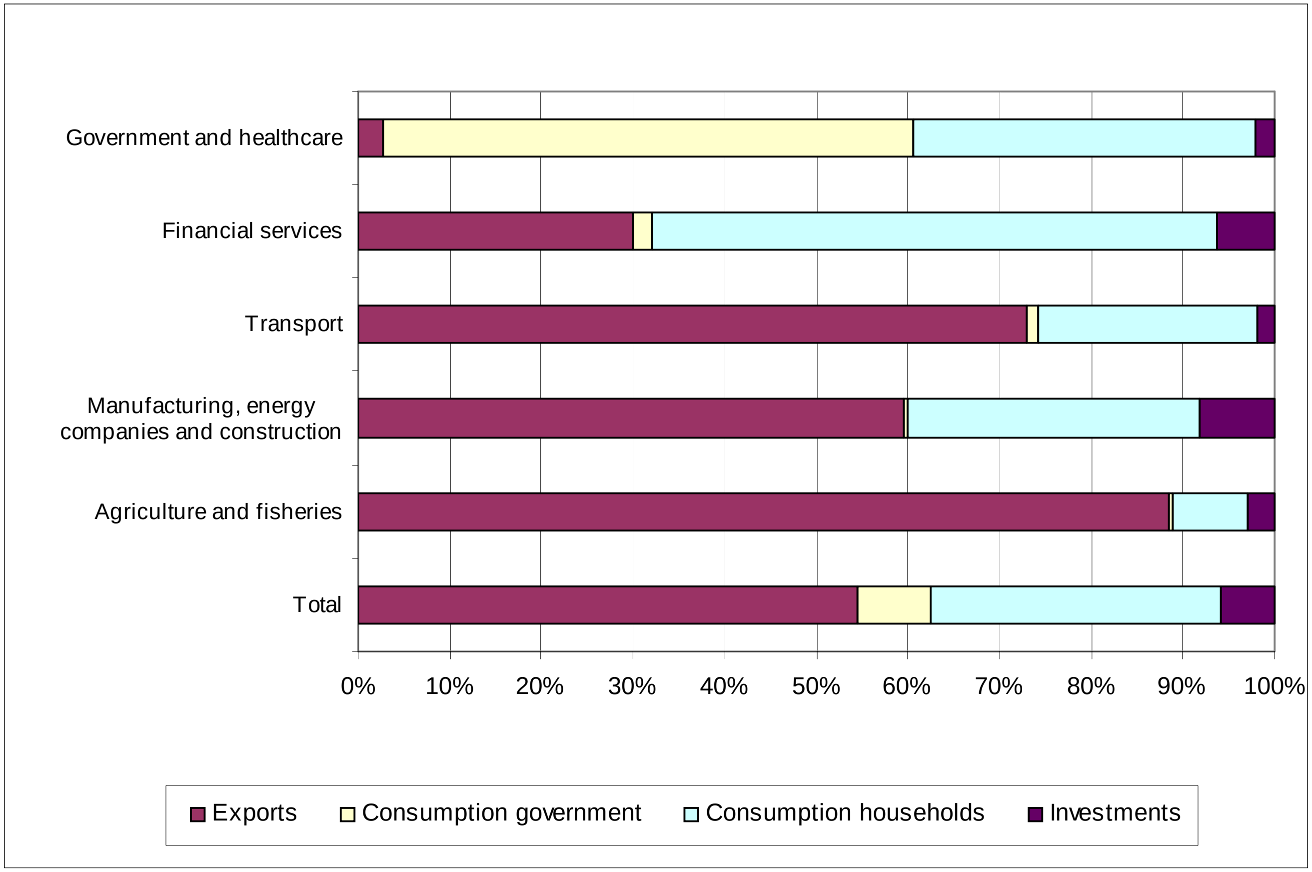
- GDP-growth
- Taxes and social contributions (%GDP)
- National saving
- National net lending
- Change in financial net worth

- Greenhouse effect
- Ozone layer depletion
- Acidification
- Eutrophication
- Waste

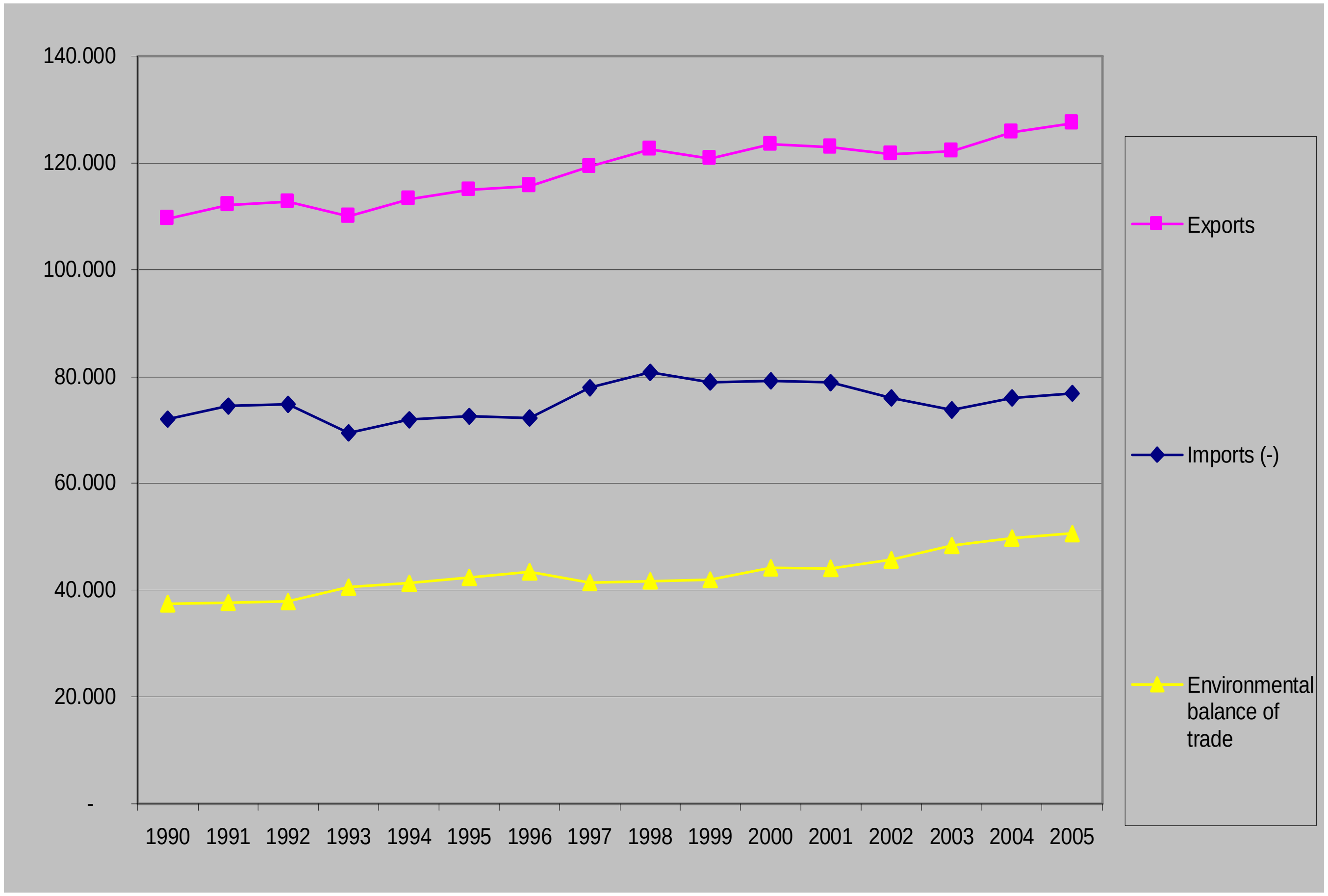
Structural decomposition analysis for CO2-emissions, 1990-2005



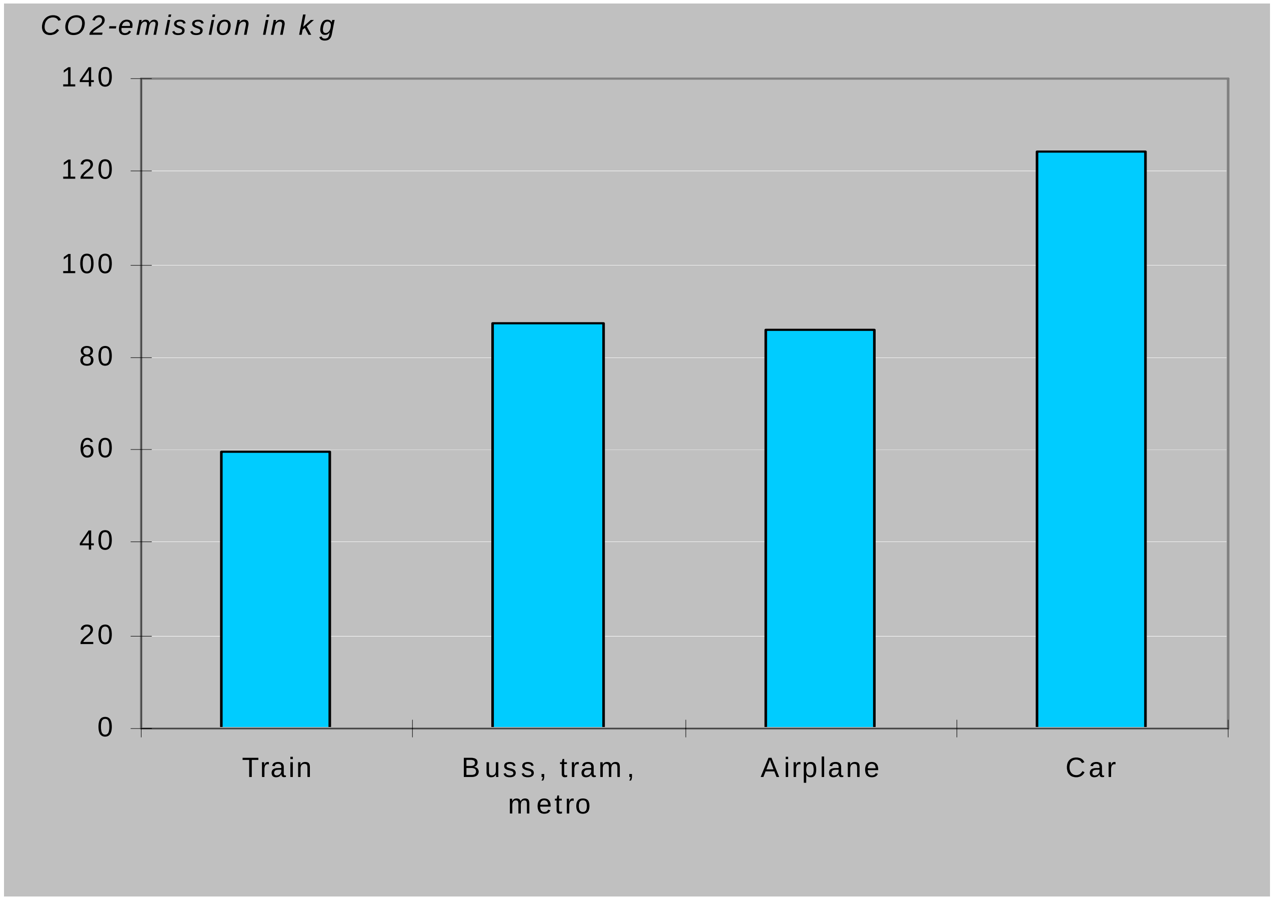
CO2-emissions attributed to final demand categories, 2005



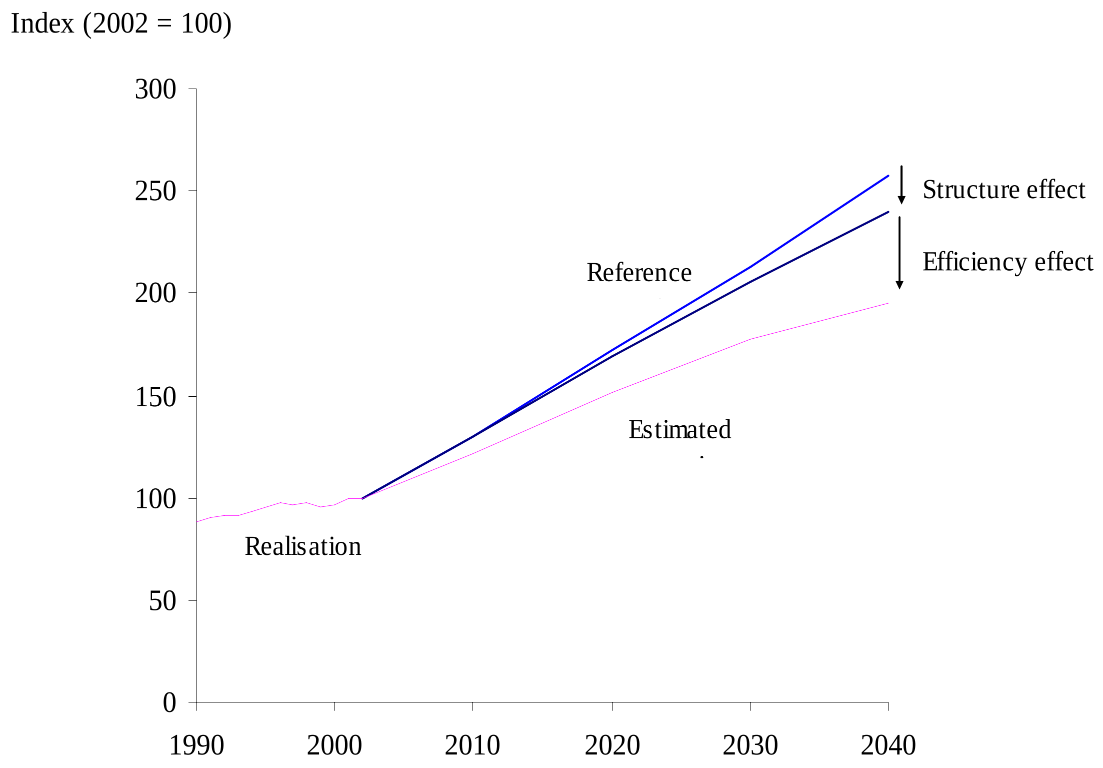
Environmental balance of trade, 1990-2005



CO2-emissions per passenger kilometre, 2003



CO2-emissions for Global Economy scenario, 2000-2040



Final conclusions

- Too much emphasis on GDP-growth
- Statisticians are sometimes blamed
- Provide information on the whole picture, a more balanced overview
- NL: Sustainability Monitor
- Internationally:
  - Elevation SEEA to statistical standard
  - Standard set of tables

Macroeconomic modelling for energy and environmental analyses

Brita Bye
Senior Research Fellow
Research Department
Statistics Norway

Contents

- Background
- The integrated macroeconomic Computable General Equilibrium model (CGE-model)
- Calibration and data requirements for the integrated CGE model
- Examples of climate policy analyses
- Future challenges

Background

- Multi sectoral general equilibrium models
  - Early approach (Johansen, 1960)
  - Current model, MSG-6, Heide et al (2004)
- Resource statistics (energy and environment, 1980-ies)
- Integrated Economy-Energy-Environment models since 1980-ies
- Regularly used by the Ministry of Finance and Statistics Norway for long term forecasting and policy analyses
- Consistent framework for economic and emission projections, and evaluation of climate policies
  - Economic welfare effects
- Mitigation – not adaption

The CGE model MSG-6

- General equilibrium model – equality in all markets in every period
- Detailed description of the production and consumption structures of the Norwegian economy, (60 commodities, 32 private industries, 19 consumer goods)
- Small, open economy characteristics (given interest rate, world market prices etc)
- Based on optimising behavior of consumers and producers
- Determines domestic production, consumption, export and import given the economy's resource constraints
- Reallocation of resources between industries and from leisure to labour
  - Measure economic welfare effects of different policies

MSG-6; an integrated economy-energy-environment model

- Detailed description of the use of energy by producers and consumers
  - Stationary (electricity, fossil fuels)
  - Transport (diesel, gasoline)
- Detailed description of production of energy mirroring Norway's special situation as a large producer of energy
  - Electricity produced by hydro power or new gas power production
  - Extraction, production and export of oil and gas from the petroleum reserves in the North Sea and the Barents Sea
- Detailed description of emissions to air – 12 pollutants
- Current carbon taxes are specified in the model
- State of the environment not included in the objective function

Calibration of MSG-6

- The economic model MSG-6 is calibrated to the National Accounts (NA)
- Empirical benchmarking of parameter values
  - Base year benchmarking to NA
  - Estimated parameters (consumer demand system using consumer survey data, production technology using NA)
  - Other relevant parameters from microeconometric analyses
- Technology is described by the base year NA
  - Only existing technologies are represented in the model
  - If new technologies are to be introduced (gas power, bio fuels in transport etc) this description must be changed

Calibration of MSG-6: Emissions

- Two sources of energy data
  - Energy data in NA based on value terms (Million NOK)
  - Energy data from the Energy Statistics are based on physical terms, (Twh, tons etc)
- Environmental statistics
  - Emission data based on Energy statisics and other sources (tons, ppt)
- Emissions data are linked to relevant economic variables in the economic model
  - 6 green house gases and
  - 6 other gases with local/regional effects
  - Calculates base year emission coefficients
- Emission model integrated part of the MSG-6 model

Figure 1. Data input to the CGE-model

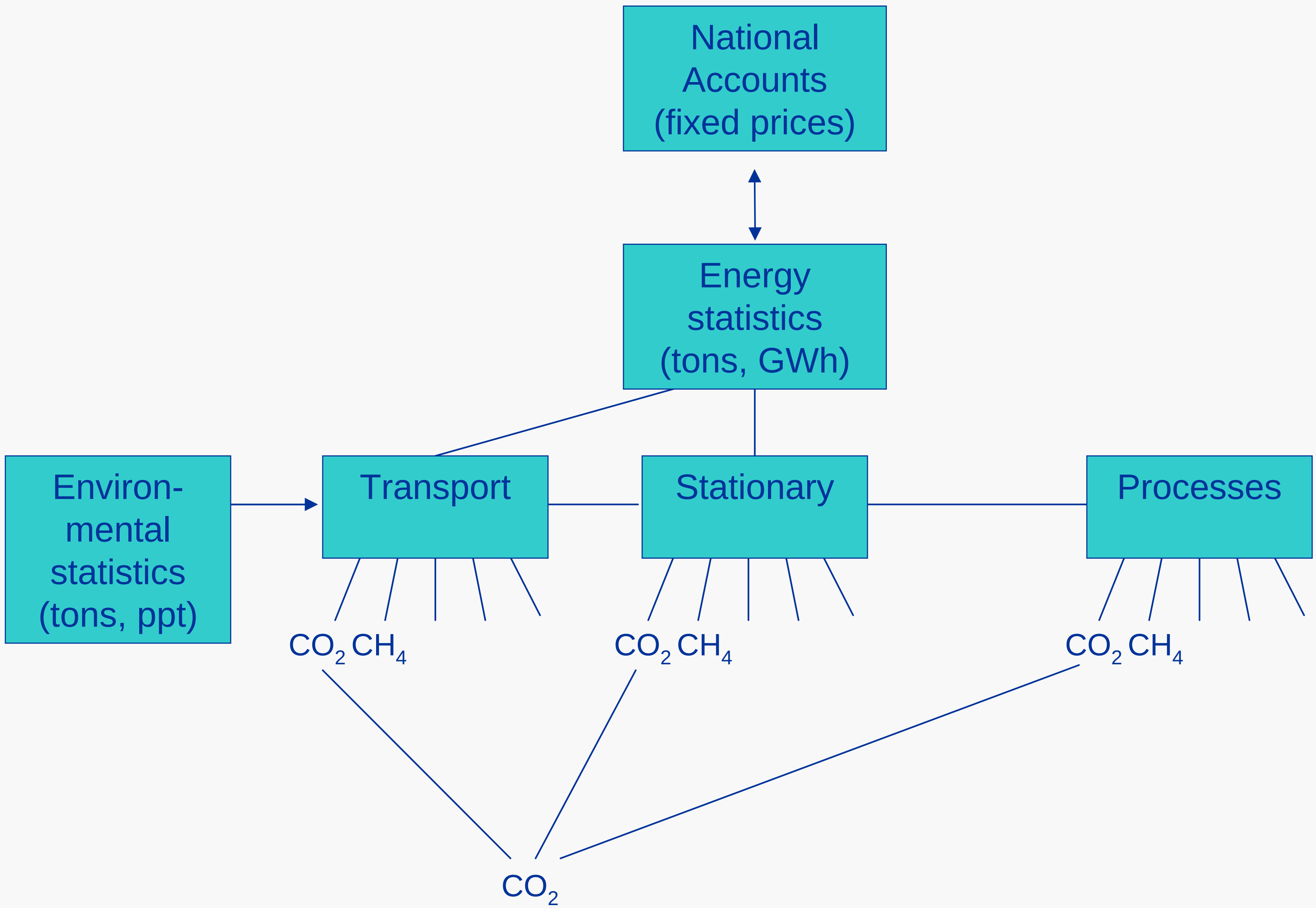


Figure 2. CGE-model

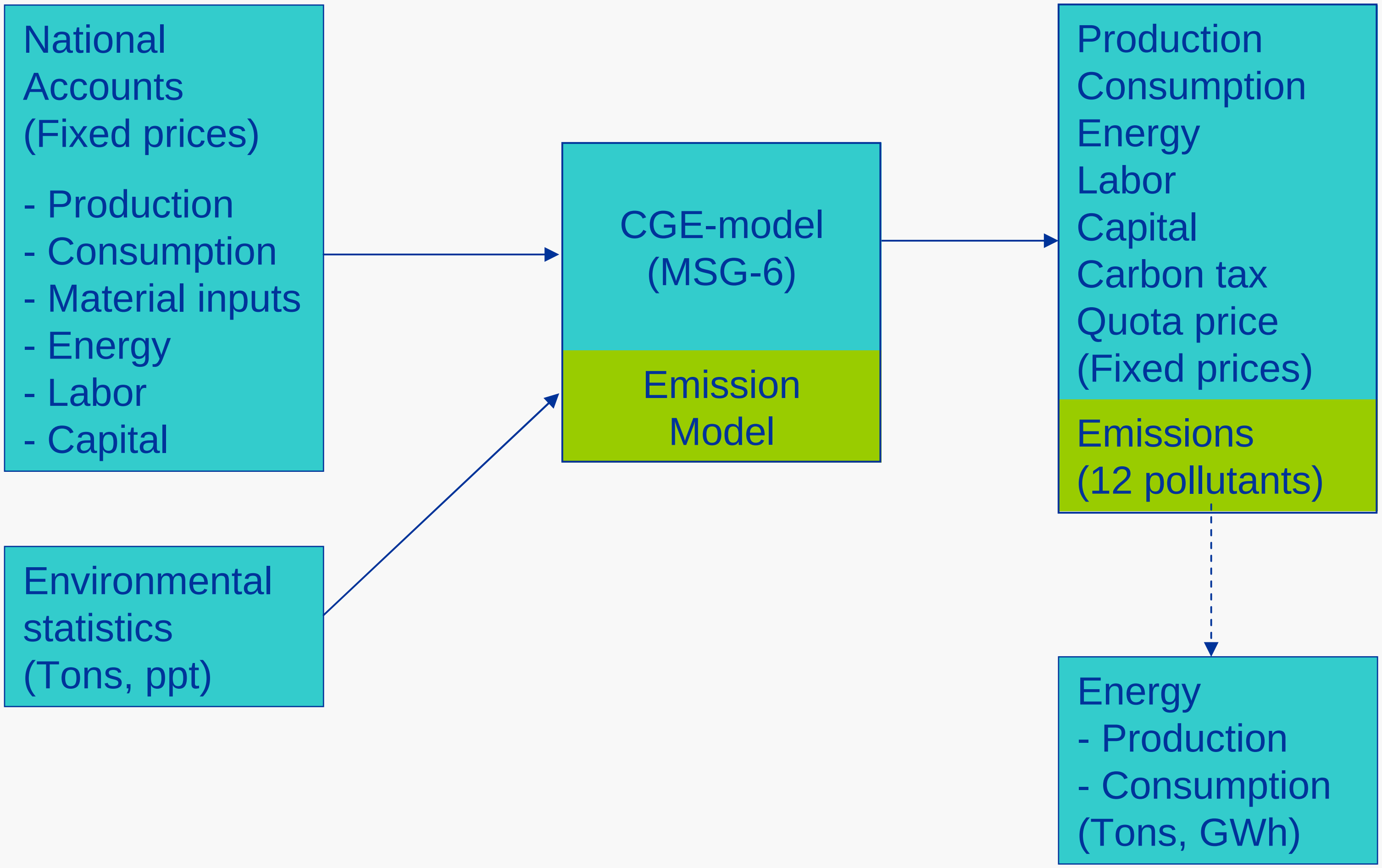


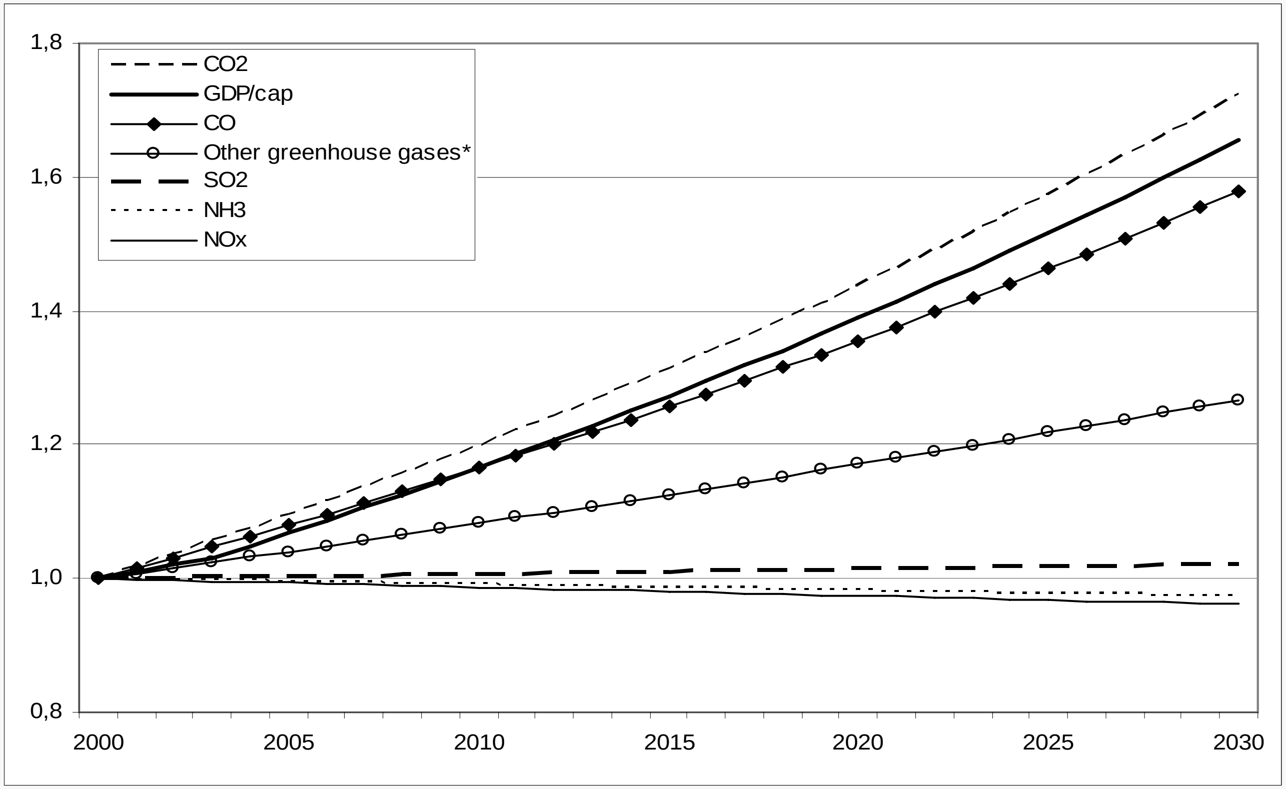
Table 1: Air pollutants and important sources in MSG-6

Pollutant	Important sources MSG-6 industry in parenthesis
Kyoto gases	
Carbon Dioxide (CO2)	Combustion of fossil fuels (Several) Reducing agents (Manufacture of metals) Gas power generation (Electricity, Oil and Gas Extraction)
Methane (CH4)	Livestock, manure management (Agriculture) Landfills Production and use of fossil fuels and fuel wood (Several)
Nitrous Oxide (N2O)	Fertilising (Agriculture), fertiliser production (Manufacture of Industrial chemicals) Road traffic (Road Transport)
Perflourocarbons (PFCs)	Aluminium production (Manufacture of Metals)
Sulphur Hexafluoroides (SF6)	Magnesium production (Manufacture of Metals)
Hydrofluorocarbons (HFCs)	Cooling fluids (Several)

Table 1 cont.

Other pollutants	
Sulphur Dioxide (SO2)	Combustion (Several) Process emissions (Manufacture of Metals)
Nitrogen Oxides (NOx)	Combustion (Several)
Carbon Monoxide (CO)	Combustion (Several)
Non-Methane Volatile Organic Compounds (NMVOCs)	Oil and gas-related activities Road traffic Solvents (Oil Refining, Road Transport, Households)
Ammonia (NH3)	Road traffic (several) Fertilising (Agriculture)
Suspended Particulates (PM2,5 and PM10)	Road traffic (Households, Agriculture, Road Transport) Fuel wood (Households)

Projections, Business as Usual (BAU)



* CH4 and N2O.

Figure 2. *GDP per capita and domestic emissions, 2000–2030, 2000 = 1.00. Source: Bruvoll and Fæhn (2006)*

Climate policies and emission targets

- Indirect regulations
  - Carbon taxes
  - Tradeable quotas
    - Free
    - Auctioned
  - Given an emission target – what is the optimal carbon tax or quota price?
    - Can be calculated by using the integrated MSG-6 model
    - Quality of data at all steps in the analysis process crucial for obtaining results that we can recommend

Climate policies cont.

- Direct regulations as:
  - Enforcement of technology changes
    - Changes in exogenous parameters in the emission model
    - Changes in factor productivity in the economic model
    - Not trivial (Low emission commision, Ministry of the Environment 2006)
      - New technologies and new products are not represented in the base year NA since they are non-observable from the statistician's point of view.
      - What are the implementation costs?
  - Issuing of non-tradeable emission quotas
    - Implemented as direct production dependent transfers

Recent climate policy analyses

- Carbon taxation and quotas
  - Double dividend (carbon tax combined with lower labour tax), B. Bye (2000a, b),
  - Differentiated taxes vs. Grandfathered quotas, Bye and Nyborg (2003),
- Environmental Kuznets curves, trade and emission leakages
  - Bruvoll, Fæhn and Strøm (2003), Bruvoll and Fæhn (2006, 2007)
- Calculations for the Norwegian Low Emission Commision
  - Åvitsland (2006)
- Norwegian carbon quota scheme
  - Bjertnæs, Hagem and Strøm (2007), Norwegian Commision on excise taxation

Trade, carbon policy and emission leakages

- Cost efficient and strengthened domestic climate policy
  - Uniform carbon tax, increasing over time (13 Euro in 2000, 58 Euro in 2030).
  - Domestic CO2-emissions are reduced by 25 % compared to BAU in 2030.
  - Small domestic welfare loss
- The pollution haven hypothesis is supported
  - Net leakages are positive
  - Global environmental benefits are reduced
- In **interaction** with the trade regime
  - Abatement costs to some extent shared with foreigners
  - Environmental costs imposed on foreigners

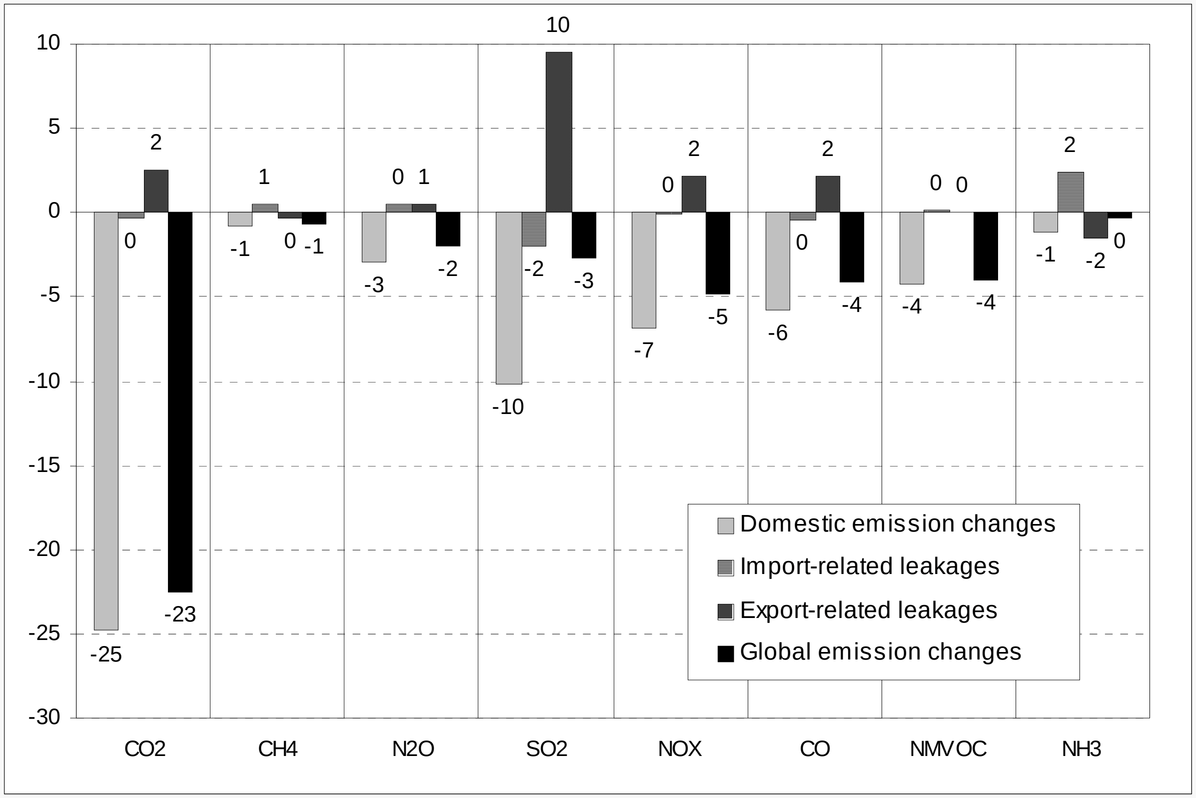
Leakages cont.

- Foreign emissions are linked to trade

  Import up -> production abroad up -> Emissions abroad up

  Export down -> substituted by foreign production -> Emissions abroad up
- Emission coefficients
  - Industry- and country specific unit emissions
  - Weights: import/export

Figure 1: Long-run changes compared to the benchmark in domestic emissions, leakages, and global emissions due to carbon taxes, in percentages. Source: Bruvoll and Fæhn (2007)



Concluding remarks and further challenges

- Consistent and high quality data at all steps in the model building process
  - Economic - > Energy - > Emissions
- Modelling technological change
  - Reaserch and Development (R&D) activities are (at present) not specified in the NA
    - R&D Statistics
  - Recent modelling development at Statistics Norway includes R&D activities, general and environmental, in a CGE model
    - Bye et al (2006, 2007, 2008)
  - R&D promoting policies and carbon emission restrictions
    - Heggedal and Jacobsen (2008)

Concluding remarks cont.

- New technologies
  - How to represent new technologies (bio-fuels, Carbon Capture and Storage etc.)
- Abatement costs
  - Resources to abatement activities are not specified in the NA
  - How to measure abatement activities
    - Where are abatement activities produced and how?
- Feed back effects?
  - Transparent indicators for sustainable development preferred
- Keep the model as simple as possible!

FINANSDEPARTEMENTET

Economic impacts of climate change

Conference on Climate Change and Official Statistics

Oslo April 15 2008

Knut Thonstad, Secretariat for Sustainable Development, Ministry of Finance

4 interesting and diverse papers/presentations

Environmental accounts are useful tools:

-Consistent with National Accounts.

-Input-output applications.

-Integrated modelling.

The presentations show different uses of such accounts:

- Canadian: Measurement of impacts of climate change
- Dutch:The use of environmetnal accounts through analysis of CO_2-emissions
- German: Analysis of embodied energy and CO_2-emission in imports and exports
- Norwegian: Long term projections of emissions.

Impact and adaptation

- Adaptation to climate change is important, and can reduce costs substantially.
- A key issue in climate negotiations.
- EU green paper. Preparing plan in Norway.
- Infrastructure with long life span is important.
- EU stresses methodoligies for asessment of impact, vunerabilities and cost effective adaptation.
- The canadian paper presents a valuable framework.
- A major challenge is how to link changes in biophysical, social and economic impacts to climate change

Dutch and German contributions

Dutch and German contributions show no trend towards Pollution heaven (carbon leakage). But until recently not strong measures against GHG.

Strong measures in developed countries without strong measures in developing countries will give carbon leakage, especially in energy intensive industries. Underscores the need for broad agreements.

We need to take more account of environmental degradation. Difficult to aggregate to one number. Use of indicators is important.

Statistics Norway and macroeconomic models

The first CGE was made in Norway in the 1960s: Multisectoral growth model. Now MSG 6.

The last decades both the macro model used for medium term policies and the long term CGE, MSG, have included detailed energy use and emissions to air.

Extremely useful that Statistics Norway combines the work on national accounts and environment and create models they and others can use.

Important for long term planning and environmental policy. The same models used in our budget process and climate policy. Every 4 years the Government present new projections for the norwegian economy and emissions to air to mid-century.

Gearing the Philippine Statistical System Towards the Measurement of the Impact of Climate Change

By

Romulo A. Virola

Estrella V. Domingo

Glenita V. Amoranto

and

Edward P. Lopez-Dee

Conference on Climate Change and Official Statistics

Oslo Norway

14 - 16 April 2008

REPUBLIC OF THE PHILIPPINES
NATIONAL STATISTICAL COORDINATION BOARD

Outline of Presentation

1. Introduction / The Philippine Statistical System
2. A Glimpse of Social, Economic and Environment Statistics in the Philippines
3. Issues and Concerns in the Generation of Statistics on Impact of Climate Change – Philippine Setting
4. The Way Forward: Mainstreaming Climate Change and Related Statistics into the Official Statistics of the Philippines

INTRODUCTION

Climate Change Impacts in the Philippines

- **The Philippines considered as one of the climate hotspot due to:**
  - ✓ **Geographical Features**
  - ✓ **Low level of economic development**
  - ✓ **Exposure exacerbated by poor access to resources.**

- **Evidence of climate change in the Philippines:**
  - ✓ **frequent occurrence of severe El Niño and La Niña events *(7 El Niño & 5 La Niña episodes from 1970-2000 compared to 2 El Niño & 3 La Niña episodes from 1950-1970)***
  - ✓ **deadly and damaging typhoons (*7 extreme tropical cyclone/southwest monsoon induced extreme events from 1991 to late 2004)***

- ✓ **Fall in agric. prod. experienced during strong El Niño events and after occurrences of severe tropical cyclones** ***(highest typhoon damage: 1.17% of GDP and 4.21% of agriculture)***
- ✓ **Massive coral bleaching in various reefs caused by elevated sea temperature during the severe 1997-98 ENSO episode**
- ✓ **Severe red tide outbreaks after the strong El Niño periods (*worst incidence of red tide in Manila Bay occurred in 1992*).**

Philippines ranked 4th in the Global Risk Index for 2006 (Germanwatch)

Objectives of the Paper

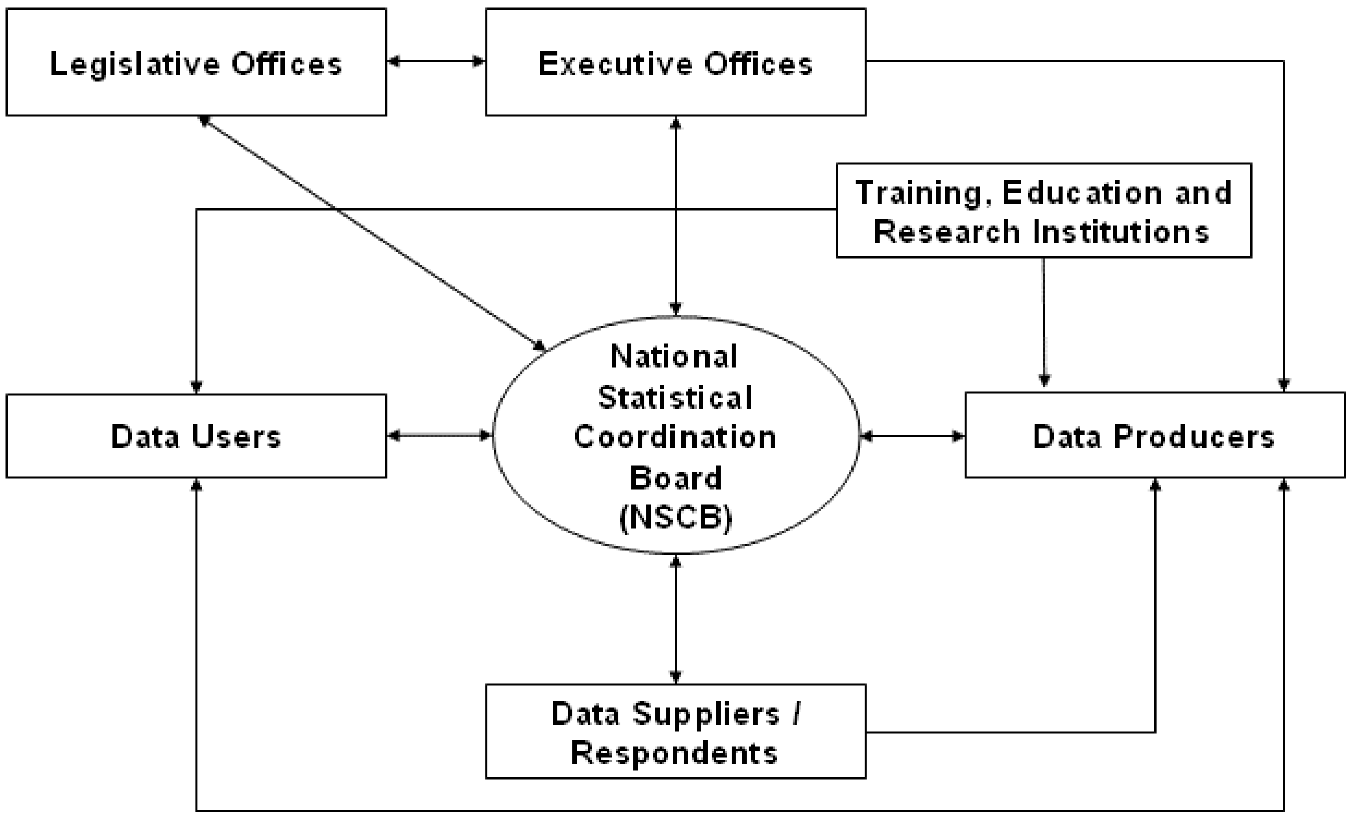
- To present the mechanisms and structures available that can strengthen the involvement of the Philippine Statistical System (PSS) in the measurement of the social impacts of climate change.
- To discuss the challenges facing the PSS in this direction.
- To present a rough framework on indicators on climate change plus some statistics that are already available, both official and non-official.

The Philippine Statistical System (PSS)

a decentralized *system composed of:*

- **a policy making and coordinating body**
- **a general purpose statistics producing agency**
- **a statistical research and training center; and**
- **all government agencies engaged in the generation of statistical information**

Framework and How It is Coordinated



Existing PSS mechanisms that would be useful in the generation of official statistics for measuring the social impacts of climate change:

a. **Philippine Statistical Development Program (PSDP)**
b. **System of Designated Statistics (SDS)**
c. **Budget Review and Prioritization**
d. **Statistical Survey Review and Clearance System (SSRCS)**
e. **Statistical Standards and Classification Systems**
f. **Technical and Inter-Agency Committees on Statistics (TCs/IACs) and Task Forces (TFs)**

g. Development and Maintenance of Statistical Frameworks and Multi-Sectoral Indicator Systems

- Philippine Framework for the Development of Environment Statistics
- Philippine Economic-Environmental and Natural Resources Accounting

h. Performance Measurement Scheme for Statistical Agencies and Other Data Producers

i. Joint PSS Programs (e.g., NSM, NCS)

j. Users' Forum

2. Socio-econ and Environment Statistics in the Philippines: Agriculture and Food Security

Indicator	Manner of Data Dissemination	Frequency	Data Source/Agency
AGRICULTURE AND FOOD SECURITY			
1. Supply and demand of agricultural commodities	Publication, website, press release	Annual	NSCB (FBS)
2. Food sufficiency ratio by type of food commodity			
3. Area planted/area harvested to palay, corn and other crops	Publication, website	Quarterly, Annual	BAS
4. Productivity (e.g., yield per hectare) - Palay, Corn, etc.			
5. Livestock and Poultry Volume of Production and Growth Rates			
6. Fishery Value of Production and Growth Rates			

Human Settlements and Society

Population count	Web release, Publication, CDs, Public Use Files	Every census year	NSO - CPH
Age and sex structure	Web release, Publication, CDs, Public Use Files		
Population density			
Population in urban and rural areas			
Population growth rate by province			
Rates of in- and out-migration			NSO (NDHS)
Net migration rate			NSO (Survey of Overseas Filipinos)
Origin-destination matrix by province			
Rates of emigration and immigration			Special Subject Survey on Migration
Net international migration			
No of overseas Filipinos			Migration Information Centers in the LGUs
Countries of origin and destination			
Proportion of families with housing units made of strong materials	Publication/Website	Every three years	NSO - FIES
	Publication/Website	Every non-FIES year	NSO - APIS
	Publication/Website	Every 10 or 5 years	NSO – CPH
Proportion of households living in makeshift housing	Publication & Website	Every three years	NSO - FIES
		Every non-FIES year	NSO - APIS
		Every 10 or 5 years	NSO - CPH
Proportion of families/households with access to safe water supply		Every three years	NSO - FIES
		Every non-FIES year	NSO - APIS
		Every 10 or 5 years	NSO - CPH
Proportion of families with access to sanitary toilet facilities		Every three years	NSO - FIES
		Every non-FIES year	NSO - APIS
		Every 10 or 5 years	NSO - CPH
Subsistence incidence		Every 3 years	NSCB
Poverty incidence			NSCB
Human development index (HDI)			NSCB/HDN

Health Statistics

Life expectancy	Publication	Annual	NSO
Crude death rate			
Infant mortality rate	Web release, Publication, CD, Diskette	Every 5 years	NDHS, NSO
Child mortality rate			
Under-five mortality rate			
Maternal mortality ratio	Publication	Varying	NDHS, NSO
Incidence of specific notifiable diseases		Annual	DOH
Causes of morbidity			
Prevalence and death rates associated with malaria			
Prevalence and death rates associated with tuberculosis			

3. Issues/Challenges in the Generation of Statistics on Social Impacts of Climate Change – Philippine Setting

- ❑ **On Framework and Indicator Systems**
  - ✓ ***Need for a Climate Change Framework and Indicator System***
  - ✓ ***Need to pursue and update Disaster Management Indicator System (DMIS), PEENRA system, and other existing relevant statistical frameworks***

- **Data Problem**
  - ✓ **Data on climate change are few**
  - ✓ **Challenges:**
    - » **Lack of statistical framework**
    - » **Data cuts across different sectors and requires expertise which official statisticians generally do not have, costly**
    - » **Data needs to be more specific to location and time of observation**
    - » **Data must typically span longer time intervals for observation**
    - » **Requires standards to measure the impact, adaptation and mitigation of climate change.**

❑ On Institutional Coordination, Linkages and Capability Building

- ***Need to Strengthen Institutional Linkages***
  - ✓IAC-ENR has to recommend to the NSCB Board the necessary statistical activities to include researches to be conducted and fund allocation.

- ***Insufficient coordinating structure at the sub national level***
  - ✓A high power inter agency body has to be established to gear regional development efforts in the planning and programming of the generation/compilation of statistics in specific geographical areas

- ***Need to strengthen capability of statistical personnel to undertake and handle statistical researches and other activities related to climate change and its social impact.***
  - ✓ **Formulation of a training agenda at the national and sub-national levels**
  - ✓ **Statistical advocacy to recognize the importance of undertaking researches on climate change**
  - ✓ **Support from the UN agencies, e.g., Statistical Institute for Asia and the Pacific, to enhance the capacity of the PSS to measure the impact of climate change**
- ***Need to to Create Awareness on Climate Change and its Impacts among Statistical Agencies***
  - ✓ **Assistance to statistical agencies and other data producers to understand issue on climate change and identify relevant data and indicators**

❑ *Resources (manpower and financial)*

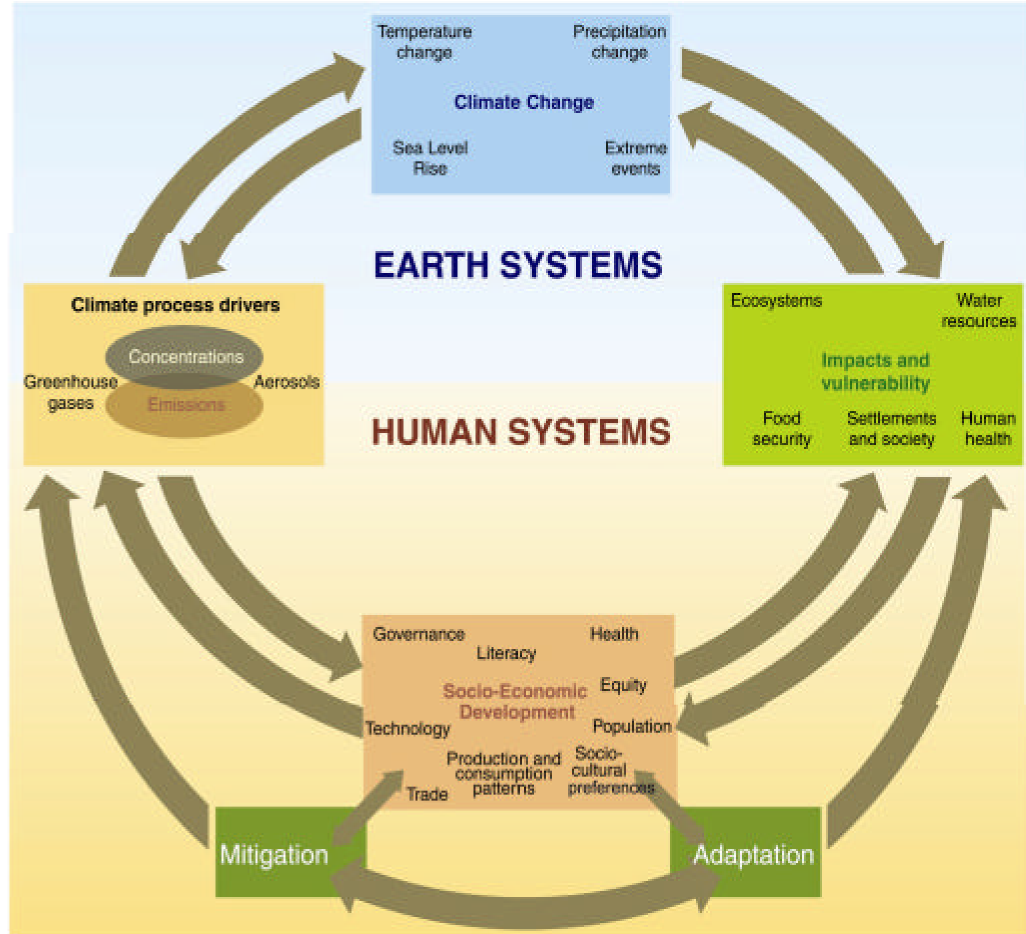
- **The PSS lacks the required resources to address issues and challenges presented on a more permanent basis**
- **National government should formulate a comprehensive study on programs and projects that need funding**
- **RDC and RSCCs should plan programs and project suited to the particularity of their locale**
- **The international community has an obligation to support developing countries in adapting to climate change.**

4. The Way Forward: Mainstreaming Climate Change and Related Statistics into the Philippine Official Statistics

- ***Integration of Climate Change Issues into National and Local Development Plan and Policies***
  - **Presidential Task Force on Climate Change seeks to address and mitigate the impacts of climate change in the country.**
  - **The Philippines is in the process of undertaking an improved national GHG inventory and preparing the country's Second National Communication.**
  - **Filing of a bill on Climate Change in the the Phil. Congress**

❑ Development of a Statistical Framework and Indicator System in Measuring/Monitoring Climate Change Impacts

Basis of the rough Statistical framework: AR4's schematic framework on climate and change



Source: Inter governmental Panel on Climate Change, Fourth Assessment Report. Climate Change 2007, Synthesis Report

The Framework:

- provides a systematic organization of the interdisciplinary nature of climate change statistics and focuses on the identification, description and presentation of data variables useful for tracing and verifying interrelationships and interdependency of the earth and human systems.
- pictures the changes in the earth system triggered by climate process drivers, the impacts and vulnerability of earth ecosystems and human system, and the coping mechanism of the human system to climate change.

Conceptual Framework

Climate Change	Climate Process Drivers	Impacts and Vulnerability	Socio-Economic Development	
			Mitigation	Adaptation
Temperature Change	**GHG Emissions / Concentration sources**	**Ecosystem (terrestrial and Marine)**	**Health**	**Health**
	Industries:	Proliferation, depletion and extinction of species		
Precipitation Change	Transport			
	Cement	Depletion/growth of growth resources	**Technology**	**Technology**
	Metal and non-metallic production		Clean Energy Development Mechanism	Clean Energy Development Mechanism
Sea Level Rise		Introduction of exotic species		
	Chemical and chemical	Changes of habitat/ecosystem		
	paper and pulp			
	etc	**Water Resources (fresh and Marine water)**		
Extreme Events			**Production and Consumption Pattern**	**Production and Consumption Pattern**
	Agriculture/Forestry	Water Depletion		
	Rice and corn production	Water quality		
	Agricultural Residue Burning			
	Grassland/Forest burning/fire	**Food Security/Safety**		
	Agricultural soils	Food Production (crops and fishery)		
			Trade	**Trade**
	Energy/electricity	Occurrence of Harmful Algal	Carbon trading	Carbon trading
	Fossil Fuel Production	Nutritional food Intake		
	Biomass burned for energy	Occurrence of crop/fishery disease and infestation		
	Grassland Burning/Kaingin (slash and Burn)			

	Waste	Human Health	Socio-Cultural preferences	Socio-Cultural preferences
	Solid wastes	Occurrence of Vector borne Diseases		
	Domestics and Commercial Waste Water			
		Occurrence of Skin Diseases		
	Industrial Wastewater	Respiratory Diseases	**Population**	**Population**
	Hazardous Waste	Diarrheal Cases	Population in coastal areas (with gender)	Population in coastal areas (with gender)
	Human Sewage			
		Settlements and Society	Population Growth/Density	Population Density/Density
		Coastal Settlements	Population control Mechanism	Population control Mechanism
		Settlement in hazardous geologic areas		
			Equity	**Equity**
			Poverty Incidence	Poverty Incidence
			Poverty level	Poverty level
			Literacy	**Literacy**
			Governance	**Governance**
			RURBAN land used Planning	RURBAN land used Planning
			Ecological Waste Management Policies	Ecological Waste Management Policies
			Water Resource Management	Water Resource Management
			Disaster Management Mechanisms	Disaster Management Mechanisms

- Operationally, the framework starts with the topics/items identified in the conceptual framework and proceeds to the identification of specific relevant variables and their corresponding units of measurement needed to quantify the earlier discussed concepts.
- The indicator system can commence with existing indicators and variables found in the PFDES, SEEA, poverty, health accounts, etc.

Statistical Framework, Climate Change

Topic	Variables	Measurement
Temperature Change		
	Climatological Normal (temperature mean, maximum and minimum)	°Celcius
	`- national	
	`- regional	
	Temperature, deviation from seasonal mean	°Celcius
	Rate of Change	
Precipitation Change		
	Amount of rainfall	millimeter
	`annual, monthly	
	` national, regional, and provincial	
	Precipitation, deviation from seasonal mean	mm, km^2
Sea Level Rise		
	Sea level increase (normal - high tide and low tide)	meter
	deviation from normal	meter
Extreme Events		
	El Niño and La Niña	number of occurrence
	Typhoon, hurricane, tornado, locaton, population/areas affected	typhoon signals, Quantity
	Floods, flash floods, locaton, population/areas affected	m, h, $km^{2,}$ quantity
	Landslides, locaton, population/areas affected	m, h, km2, quantity
	Tidal Waves, locaton, population/areas affected	km^2, quantity

Statistical Framework, Climate Process Drivers Change

Topic	Variables	Measurement
GHG Emissions / Concentration sources		
Industries:	(can be sourced from environemental accounts)	
Transport	total emissions by type of vehicles	tons/year
Cement	total emissions by type of industry	tons/year
Metal and non-metallic production	toxic air contaminants	tons/year
Chemical and chemical products		
paper and pulp		
etc		
AgricultureForestry		
rice and corn production	Rice and corn production	tons/year
	Area of production (provincial, municipal)	Gg
	Total Ghg emission from rice and corn produciton	hectare
Agricultural Residue Burning	Area burned/kaingin areas	hectare
Grassland Burning	Forest Fires	hectare
Agricultural soils		
Energy/electricty		
Fossil Fuel Production	energy resources production (by sector, by utility)	by capacity (gwh)
	Depletion of energy resources	volume (thousand metric tonnes)
	Energy conversion (by plant, utility)	by capacity (gwh)
Biomass burned for energy	Energy Consumption (by sector, source)	by capacity (gwh)
Waste		
Solid wastes	solid waste disposal/ generation	tons per year, kilogram per capita
Domestics and Commercial Waste Water	toxic waste generated	tons per year, kilogram per capita
Industrial Wastewater	waste disposal in landfill	tons per year, kilogram per capita
Human Sewage	Volume of human sewage	tons per year, kilogram per capita
Hazardous Production	volume of hazardous waste	tons per year, kilogram per capita

Statistical Framework, Climate Change Impact and Vulnerability

Topic	Variables	Measurement
Ecosystem (terrestrial and marine)		
Proliferation, depletion and extinction of species	Number/types of extinct, endangered, vulnerable, etc species	
	Number/types of introduced species	
Depletion/growth of growth resources	Forest area cleared for agricultural production	Hectare
	Area harvested/used in kaingin	Hectare
	Volume of log production	Cubic meter/year
	Area of change	Percent change
	Fish Production (marine, inland municipal and aquaculture)	Tons, kg
Changes of habitat/ecosystem	Mangrove areas converted for aquaculture production	Hectare, km^2, pesos
	Loss of Seagrass Beds	
Water Resources (fresh and Marine water)		
Water Depletion	Amount of surface (by source, rivers, lakes) and groundwater abstraction	Cubic meters per year, liters per second
	Amount of surface (by source, rivers, lakes) and groundwater abstraction for use in irrigation, commercial, domestic and industrial	Cubic meters per year, liters per second
	Average stream flow	Cubic meters per second
	(Can be sourced from environmental accounts)	
	Number of sites used for inland, municipal fishery	Number of sites
Water quality	Water quality of receiving water bodies	Concentration (mg/l)
	Number of areas affected by flood	Number, hectares, depth
	Number of rivers, lakes, open waters affected by sedimentation	Number of rivers and lakes affected

Impact and Vulnerability, con't

Food Security/Safety		
Food Production (crops and fishery)	Volume of rice/rice production	kilograms, tons
	Volume of fish production (inland, marine and aquaculture	kilograms, tons
Occurrence of Harmful Algal Blooms (HABS)	Number of occurrence and location	
Nutritional food Intake		calorie
Crop/fishery disease and infestation	Number of occurrence, type of disease and infestation	
Human Health		
Occurrence of Vector borne Diseases	number of occurrence/cases, type, location	
Occuence of Skin Diseases	number of occurrence/cases, type, location	
Respiratory Diseasea	number of occurrence/cases, type, location	
Diarrheal cases	number of occurrence/cases, type, location	
Human Settlements		
Coastal Settlements	Population size, density, dissagregation (male and female)	
Settlement in hazardous geologic areas	Population size, density, dissagregation (male and female), location	

Statistical Framework, Socio-Economic Development - Mitigation and Adaptation

Topic	Variables	Measurement
Health		
Technology		
Clean Develoment Mechanis		
Production and Consumption Pattern		
Trade		
Carbon trading		
Socio-Cultural preferences		
Population		
Population in coastal areas (with gender)		
Population Gorwth/Density		
Equity		
Poverty thresholds		
Poverty level		
Literacy		

- **The framework needs further development as researches on climate change and its impacts become available.**

❑ Designation of Climate Change Statistics

- The list of designated statistics has to be reviewed to include climate change impact and ENR statistics/indicators
- The current designated statistical activities, e.g., field health service information system, energy and water, etc., have to updated to include salient features of climate change impact statistics

❑ Standards and Classification System

- ➢ **IAC-ENR can select the terms from existing laws which have statistical bearing for approval of the NSCB Executive Board for adoption as official climate change/ENR terms to be use for statistical purposes.**
- ➢ **PSS can lay down the standard methodologies and techniques in data collection, processing and presentation to ensure comparability of statistics produced by the government.**

❑ Partnership Among Gov't Agencies, Academe and Research Inst's for Continuous Improvement of Climate Change Statistics

- **Statisticians to collaborate with other scientists to advance their understanding on the nature, causes, and impacts of climate change**
- **Government can gear its science and technology research towards climate science and climate change impact.**
- **Different government agencies, national and local, should involve research institutions and academe in formulation of plans and programs on climate change.**

❑ Research and Training

- ➢ SRTC can develop a comprehensive and integrated research and training program on theories, concepts and methodologies in climate change and its impact.
- ➢ Key specific research priorities might deal on:
  - ✓ Enhancing capability to establish and maintain observation facilities and to collect, and compile climate, social and biophysical data;
  - ✓ Measuring impacts of extreme weather events, i.e., human diseases from flood, storm surges, sea level rise, plant and insect pests;
  - ✓ Identification of social vulnerability to multiple stressors due to climate change environmental change
  - ✓ Identification of critical climate thresholds for various sectors in different locale

Maraming salamat po!

URL: http://www.nscb.gov.ph
e-mail: info@nscb.gov.ph

Integrated Environmental-Economic Accounts

for

Tradeable Carbon Dioxide Emission Permits

Thomas Olsen, Statistics Denmark

Conference on Climate Change and Official Statistics

Oslo, Norway 14 – 16 April 2008

STATISTICS DENMARK

Purpose

- To introduce the Environmental-Economic Accounting framework as a means for organizing data on CO_2 permits

Outline

- Features of the Emission Trading Scheme
- The System of Environmental-Economic Accounting (SEEA-2003)
- Physical CO_2 permits accounts
- Monetary CO_2 permits accounts

STATISTICS DENMARK

The Emission Trading Scheme

- One of the means for meeting the reduction obligations committed to under the Kyoto-protocol
- Part of the global market
- The permits gives the right to emit 1 ton of CO_2
- Different participants on the market
- Different types of permits
- Physical as well as monetary aspects

STATISTICS DENMARK

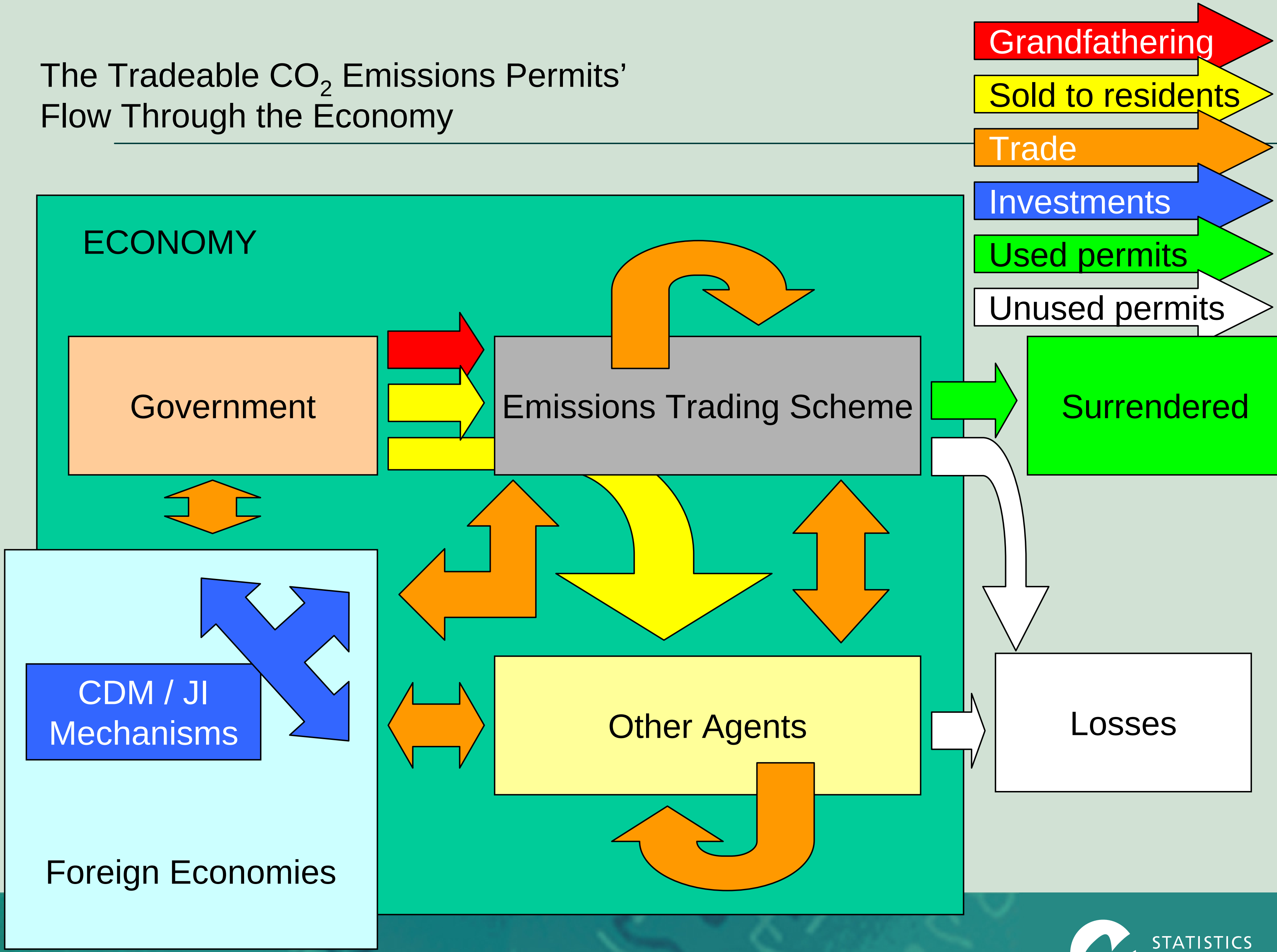
SEEA-2003

- Satellite system of the System of National Accounts (SNA)
- Set of definitions, classifications, statistical accounts and tables
- Allows incorporation of environment and energy statistics into the national accounting framework
- Analyse interaction between environment and economy and between environmental domains

The permits' flow through the economy

- The creation of the permits
- Agents in the Emission Trading Scheme
- Other agents

The Tradeable CO_2 Emissions Permits' Flow Through the Economy



Physical CO_2 permits accounts

- Data source: The CO_2 permit registry
- Link to the National Accounts industry classification

- Statistics on the CO_2 permits
- Link to the Environmental Accounts
- Link to the National Accounts

Questions that could be answered

- What are the origins of the CO_2 permits?
- From where have the industries received the permits?
- Who owns the permits?
- Who is trading with the permits?

STATISTICS DENMARK

Questions that could be answered, cont'.

- Relationship between the use of energy and the CO_2 emissions
- Relationship between CO_2 emissions and permits
- Relationship between CO_2 permits and environmentally related taxes and subsidies
- Economy: Output, Gross Value Added, Employment

STATISTICS DENMARK

Results from a Danish experience

Balance sheet. Denmark, 2005.

Industries	**Opening stock** (1)	Allocated (2)	Purchased (3)	CDM credits (4)	JI credits (5)	Sold (6)	Surren-dered allowan-ces (7)	Surren-dered (fines, etc) (8)	**Closing stock** (=1+...+5-6-7-8)
	1 000 allowances / 1 000 tonnes CO_2								
Total	**0**	**37 371**	**NA**	**NA**	**NA**	**NA**	**26 471**	**0**	**10 901**
Households	0	0	NA	NA	NA	NA	0	0	0
Total industries	**0**	**37 371**	**NA**	**NA**	**NA**	**NA**	**26 471**	**0**	**10 901**
1 Agriculture, fishing and quarrying	0	3 056	NA	NA	NA	NA	2 328	0	728
2 Manufacturing	0	7 525	NA	NA	NA	NA	5 438	0	2 087
3 Electricity, gas and water supply	0	26 790	NA	NA	NA	NA	18 704	0	8 086
4 Construction	0	0	NA	NA	NA	NA	0	0	0
5 Wholesale and retail trade; hotels, rest.	0	0	NA	NA	NA	NA	0	0	0
6 Transport, storage and communication	0	0	NA	NA	NA	NA	0	0	0
7 Financial intermediation, business active.	0	0	NA	NA	NA	NA	0	0	0
8 Public and personal services	0	0	NA	NA	NA	NA	0	0	0

STATISTICS DENMARK

Results from a Danish experience, cont'.

Gross use of energy, CO_2 emissions, CO_2 permits and the link to the economy. Denmark, 2005.

	Industries	Gross use of energy	CO_2 emissions	Surrendered permits	CO_2 permits allocated	Energy related taxes	Energy related subsidies	Gross value added	Employment
		TJ	1 000 tonnes CO_2 / allowances			Mill. Dkk			Persons
	Total	**1 810 902**	**95 486**	**26 471**	**37 371**	**36 370**	**244**	**1 164 096**	**2 722 123**
	Households	268 311	13 843	0	0	21 764	25		
	Total industries	**1 542 591**	**81 642**	**26 471**	**37 371**	**14 606**	**206**	**1 164 096**	**2 722 123**
1	Agriculture, fishing and quarrying	81 618	4 988	2 328	3 056	931	3	**63 924**	85 614
2	Manufacturing	469 705	8 356	5 438	7 525	2 251	106	167 395	384 504
3	Electricity, gas and water supply	338 207	25 964	18 704	26 790	95	1	21 917	13 219
4	Construction	18 692	1 369	0	0	1 193	1	59 979	170 236
5	Wholesale and retail trade; hotels, rest.	43 601	1 269	0	0	2 193	10	159 227	518 404
6	Transport, storage and communication	528 299	37 950	0	0	2 954	4	105 643	176 861
7	Financial intermediation, business active.	17 755	471	0	0	1 323	10	282 641	397 900
8	Public and personal services	44 715	1 275	0	0	3 667	72	303 370	975 385

Global carbon market

- 2007: c € 40 bn.
- 2008: c € 60 bn.
- European market constitutes approximately two thirds

Monetary CO_2 permits accounts

- The corresponding monetary values based on the physical CO_2 permits accounts
- Valued at the average CO_2 permit price
- The basis for the description in the National Accounts

STATISTICS DENMARK

Summary

- Complex market for CO_2 permits
- Integrated Environmental-Economic Accounting is a way of structuring information
- Enables to systematically analyse the impact of the economy on the environment, and vice versa
- Enables consistent analyses of the economic activity, the use of energy, the associated CO_2 emissions, environmentally related taxes and subsidies as well as the CO_2 permits

STATISTICS DENMARK

Contact information

Thomas Olsen, Statistics Denmark

E-mail: Tol@dst.dk

STATISTICS DENMARK

Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

Monitoring Climate Change Mitigation on the Context of National Sustainable Development Strategies

Matthias Bruckner
Division for Sustainable Development
Department of Economic and Social Affairs
United Nations

Outline

1. Role of national sustainable development strategies (NSDS) in addressing climate change
2. Monitoring an NSDS and the role of official statistics
3. Climate change mitigation policies in NSDS – country experiences and monitoring needs

UN DESA – Division for Sustainable Development

- Mission Statement: To provide leadership and to be an authoritative source of expertise within the United Nations system on sustainable development
- DSD serves as the Secretariat of the Commission on Sustainable Development (CSD)
- CSD:
  - Functional Commission of the UN Economic and Social Council (ECOSOC)
  - Attended by non-CSD member states, UN system, NGOs and IGOs
  - Includes high-level segment with 60-70 ministers in attendance
- DSD conducts normative work, analytical work and technical cooperation

NSDS and climate change

- What is an NSDS?
  - ***A coordinated, participatory and iterative process*** to achieve economic, environmental and social objectives in a balanced and integrated manner.
- Who has an NSDS?
  - All countries committed to NSDS in Rio de Janeiro in 1992 and at the World Summit on Sustainable Development in Johannesburg in 2002.
  - 82 countries have reported to the CSD or to DSD that they are implementing a NSDS in 2007.

NSDS and climate change

- Benefits of addressing climate change in an NSDS
  - An NSDS provides a natural framework for climate change mitigation and adaptation policy, as the global intergovernmental consensus recognizes climate change as sustainable development issue;
    - Preamble of UNFCCC: "...responses to climate change should be coordinated with social and economic development in an integrated manner..."
    - Bali Action Plan, para 1 b: "Enhanced national/international action on mitigation of climate change, including, inter alia, consideration of ... (ii) nationally appropriate mitigation actions by developing country Parties in the context of sustainable development;"
  - an NSDS facilitates the identification and valuation of co-benefits of climate change actions on other sustainable development issues;

NSDS and climate change

- Benefits of addressing climate change in an NSDS
  - an NSDS facilitates harnessing co-benefits from actions driven by non-climate objectives;
  - an NSDS enables country to identify and solve trade-offs between climate change and other objectives;
  - intergenerational equity is at the heart of the concept of sustainable development and of the climate change challenges;
  - as global partnership forms an integral part of the sustainable development agenda, an NSDS facilitates the consideration of other countries' concerns;
  - as an NSDS is a participatory process, it facilitates the engagement of non-state actors.

Monitoring an NSDS

- Three broad elements of an NSDS require monitoring:
  - Actions and activities planned in the NSDS;
  - Effects and impact of NSDS on sustainable development;
  - Progress towards sustainable development.
- Institutional arrangements for monitoring should be clarified from the beginning.
  - Choice depends on overall national institutional structure.

Monitoring an NSDS

- Official statistics play an important role in monitoring an NSDS:
  - – Provision of high-quality data (data collection and integration) for monitoring strategy impact and overall progress;
    - Common types and sources of data needed
      - – National accounts
      - – Censuses
      - – Household and other surveys
      - – Administrative records
      - – Estimations based on agreed standards;
  - – Provision of statistical methodologies and standards;
  - – Official statistics may have a lead role in monitoring and reporting strategy impact and overall progress, especially if broad elements are monitored separately and not in an integrated manner.

Monitoring an NSDS

- Other main actors in monitoring an NSDS
  - Institution in charge of coordinating NSDS
    - Inter-ministerial committee, presidential commission, NSDS council or lead ministry (Ministry of Finance, Ministry of Planning, Ministry of Environment);
  - Actors implementing NSDS (self-monitoring), especially for monitoring NSDS actions;
  - Other governmental agencies, such as governmental accounting offices (for monitoring NSDS actions and possibly NSDS effects);
  - Research institutions or other non-governmental institutions.

Country experiences
Overview

- Most countries address climate change in their NSDS
  - Forty-four out of 59 countries included in a recent study by DSD address climate change mitigation;
  - twenty-two address climate change adaptation;
  - eleven do not address climate change explicitly.
- Wide range of policy instruments included in NSDS:
  - Economic (subsidies, tax exemption, ...);
  - Regulations, mandatory and voluntary standards, voluntary arrangements with private sector;
  - Developing new and revising existing strategies and management practices;
  - Providing information;
  - Research;
  - Awareness campaigns.

Country experiences
Common objectives and monitoring requirements

- The following table lists some common objectives/aims related to climate change mitigation found in 44 NSDS as well as indicators needed for monitoring.
- List is illustrative and not exhaustive.
- Actual formulation and specification of objectives/aim differ across country.
- Indicators and measurement methods also differ.

Country experiences
Common objectives and monitoring requirements

Objective/aim	Indicators
Limit growth of or reduce GHG emissions, total and/or by sector (energy, transport, waste, agriculture,...)	GHG emissions, total and by gas and sector
Decouple GHG emissions from economic growth	GHG emissions per unit of GDP
Participate actively in international climate negotiations	
Prepare national communications under the UNFCCC (non-Annex 1 countries)	

Country experiences
Common objectives and monitoring requirements

Objective/aim	Indicators
Increase use renewable energy sources	Share of renewable sources in electricity generation and/or total energy consumption
Improve energy efficiency in energy production, industry, transport, agriculture, buildings, energy appliances	Various sector-specific energy intensity indicators; sector-specific greenhouse gas emission intensity
Limit growth of or reduce energy consumption	Energy consumption, total, per-capita and/or by sector
Develop new technologies (RE, clean coal, …)	

Country experiences
Common objectives and monitoring requirements

Objective/aim	Indicators
Enhance carbon sinks through reforestation, afforestation and avoided deforestation	Deforested area; reforested area; total area covered by forests
Promote sustainable forest management	Area under sustainable forest management
Expand Payment for Ecosystem Services schemes (includes carbon absorption)	Land area under PES schemes
Increase carbon sinks in agriculture	Agriculture land used as carbon sink; area under ecological farming

Country experiences
Common objectives and monitoring requirements

Objective/aim	Indicators
Acquire emission units through flexible mechanisms under the Kyoto Protocol (CDM, JI)	Amount of emission units acquired
Benefit from CDM projects and other market mechanisms	Number of projects; avoided emissions
Ensure that CDM projects promote sustainable development	
Incorporate climate change in international cooperation, trade and investment policies	

Thank You

Contact: Matthias Bruckner
Division for Sustainable Development
Department of Economic and Social Affairs
United Nations

email: brucknerm@un.org
http://www.un.org/esa/sustdev/index.html

The use of climate change statistics to inform national policy on mitigation: UK climate change programme

Martin Nesbit

Director for Evidence

Climate Change Group

UK Department for Environment, Food and Rural Affairs

Overview

- UK policy on emissions is set out in a comprehensive **Climate Change Programme**. Current **legislation** before Parliament sets out new high-level process for managing UK emissions.
- UK **inventory methods are robust**, and comply with IPCC guidance. **Political focus**, and **high profile targets**, put the data and targets under **intense political scrutiny**.
- Policy makers need a **clear understanding of the basis** of inventory and other data; and need to promote informed public debate. Particular issues include:
    - Treatment of emissions from **international aviation**
    - Embedded emissions from **net UK imports** of carbon-intensive goods
    - Potential in some sectors (e.g. **agriculture**) for policies aimed at reducing inventory record of GHG emissions to be counter-productive
- Understanding of data needs relating to the **economic impacts** of mitigation options needs to be improved.

Climate Change Programme: UK progress – greenhouse gases

- UK’s Kyoto Protocol target is to reduce its greenhouse gas emissions to 12.5% below base year levels by 2008-12
- UK greenhouse emissions were 16.4% below 1990 levels in 2006 or 20.7% below when the impact of the EU ETS is taken into account
- Projected to be more than 23% below 1990 levels by 2010, including the impact of the EU ETS

Key elements of the Climate Change Bill

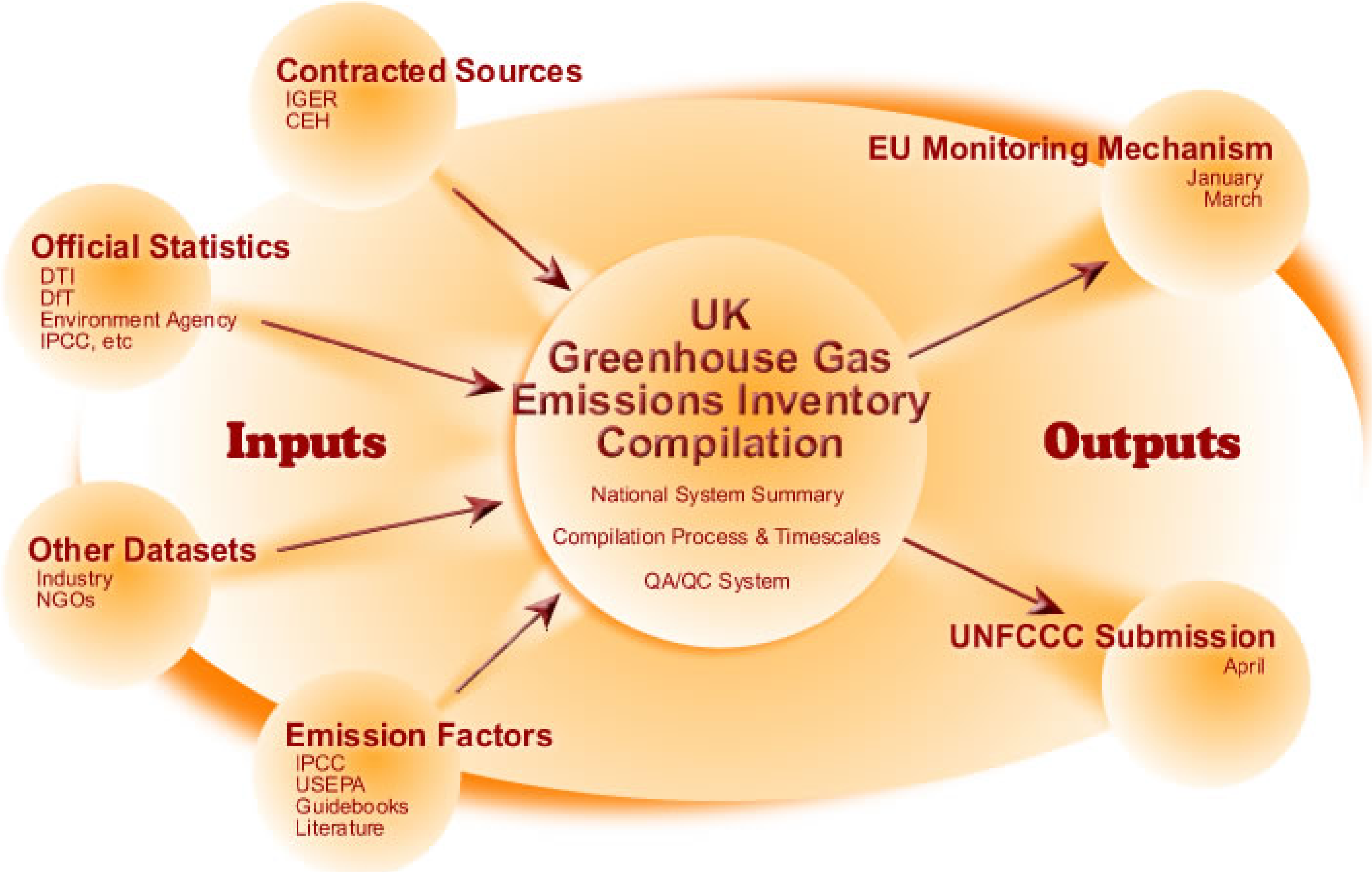
defra
Department for Environment Food and Rural Affairs

Targets	Long and medium term targets: CO_2 emission reductions of at least 60% by 2050 and by at least 26% by 2020, through action in the UK and abroad
Budgets and accountability	Five-year carbon budgets to set out our trajectory, backed by annual progress reporting to Parliament
Committee on Climate Change	New independent body to advise Government on carbon budgets and where least cost savings could be made
Measures to reduce emissions	Powers to introduce emissions trading schemes more quickly and easily, including new Carbon Reduction Commitment. Biofuels. Waste.
Adaptation	Government to report at least every five years on climate change risks, and programme to address them

Statistical approach

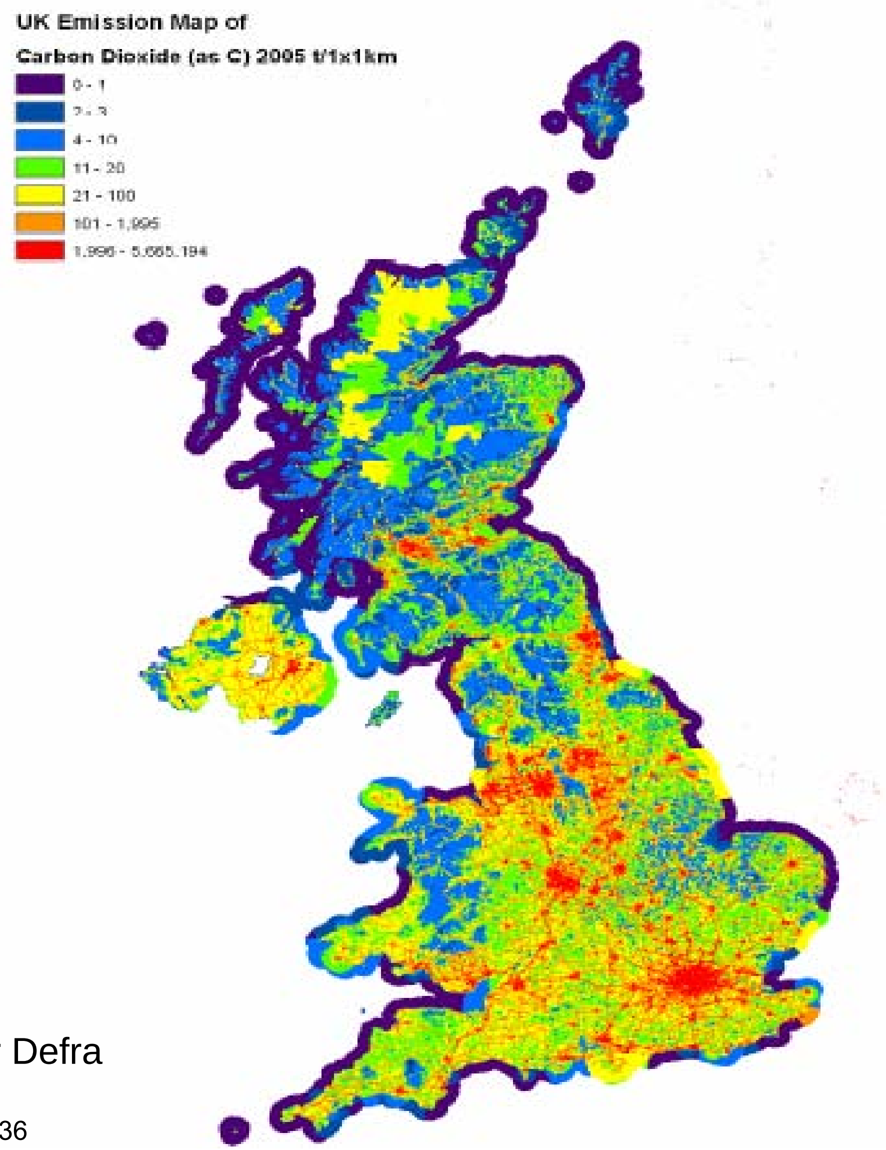
- Inventory consistent with IPCC guidance, an international requirement
- Basic methodology uses (activity x emissions factor) calculation
- Reviewed annually by international team coordinated by UNFCCC
- Uncertainties fully quantified, using internationally agreed methods
- Valid (and obligatory) choices raise some political issues:
  - Emissions **within national boundary** included in national total
  - **international aviation and shipping** reported but not included – consistent with international agreement

Preparation and use of UK inventory



Example map

UK emissions of carbon dioxide in 2005



Source : AEA Report for Defra

Quality of statistical evidence

Inventory seems robust

- Over 80% of inventory based on fossil fuel statistics – national and international checks apply, energy balance checked and emission factors reviewed annually
- Other categories – transparent estimates based on published statistics wherever available. Inventory agency applies consistency checks from year to year.

But interested in other NSO experiences – eg with outlier detection or other methods to check data quality.

However, some issues raised by a recent National Audit Office report on the **use** of our data in policy-making. In particular:

- Should policy take greater account of consumption-based emissions?
- Should progress against emissions targets be calculated with reference to the purchase of emissions reductions in other economies, through emissions trading?

And debate on the current Climate Change Bill has drawn attention to the issue of whether to include international aviation and maritime emissions in the total to which targets apply.

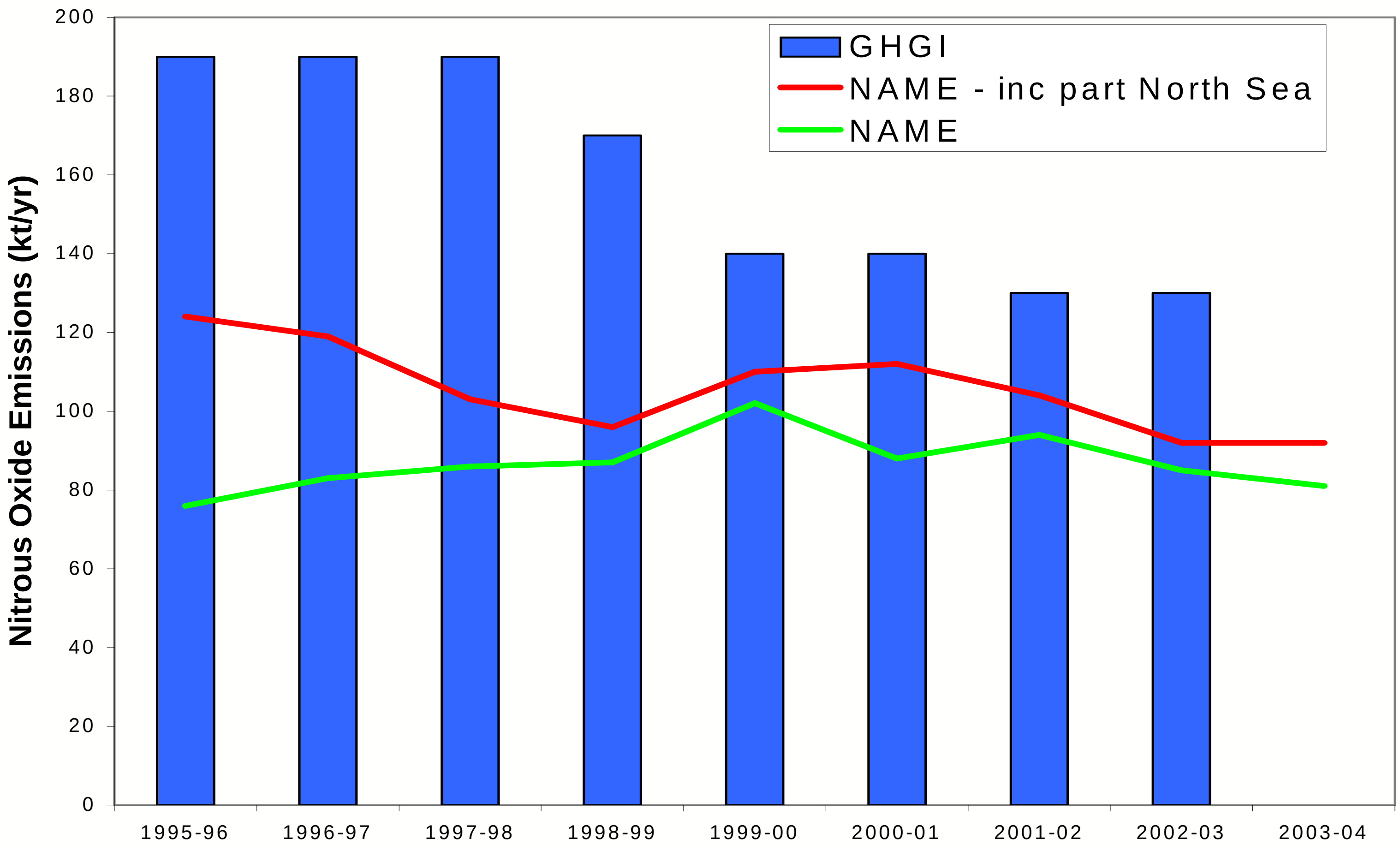
Policy issues:
i) Aviation & shipping emissions

- Emissions estimated from consumption of fuel by domestic *and* international aviation and shipping
- Only domestic estimates included in the national total. International aviation and shipping emissions reported but not included in national total.
- This follows international agreements, but omission from the national total is consistently raised as a gap by UK stakeholders
- Government target has always explicitly excluded international aviation and shipping in formal documentation – but this has not always been made clear in political discourse.
- Domestic/international issue is mainly political rather than statistical; but brings statistics into controversial political territory.
- Allocation between domestic and international can be tricky and statisticians may be able to help develop methods.
- Political issue facilitated by inclusion within EU Emissions Trading Scheme; but data issues potentially complicated, because ETS works on a different basis for allocation.

Policy issues:
ii) Embedded emissions

- Internationally agreed territorial approach neither includes emissions embedded in imports, nor excludes emissions from exported goods
- Internationally agreed method for embedded emissions unlikely, given
  - current focus on territorial basis
  - Computational difficulty and uncertainty in making the estimates
  - potential difficulty in reaching agreement (e.g. given the experience with attribution of international aviation and shipping emissions).
- Could suitable statistics still help to shape policy-making in individual countries, even if routine methods not feasible?

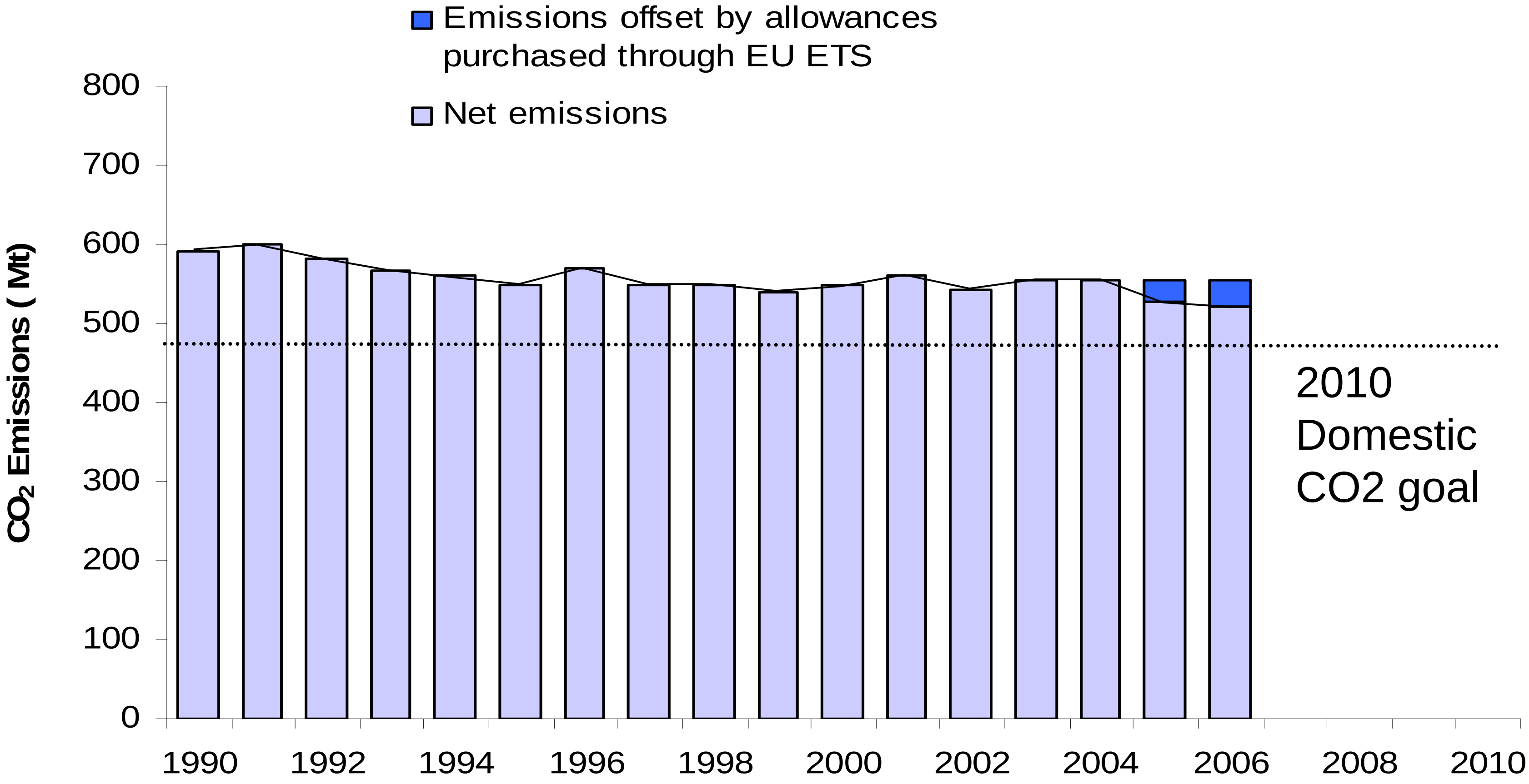
Embedded emissions: comparison of datasets based on consumption (NAME) with inventory



Policy issues:
iii) Emissions trading

- UK publishes separate results showing emissions reductions *within the UK* and reductions *funded by the UK*
- Kyoto Protocol includes trading schemes, so we need to report the *funded by the UK* figure
- 2006 results
  - UK acquired 33.3 Mt of credits through EU ETS
  - CO_2 emissions *within the UK* = 554.5 Mt
  - 6.4% below 1990 levels
  - CO_2 emissions *funded by the UK* = 521.2 Mt
  - 12.0% below 1990 levels
- should EU statisticians work together to present consistent results?
- should we be making more systematic use of different data streams (e.g. inventory calculations; verified emissions; other data on sectoral economic activity) to ensure results in each are robust?

Impact of emissions trading



Statistics issues
(i) Scope for improvements in UK reporting

- Formal procedures exist for energy data, consistent with UK National Statistics code of practice.
- We are developing Data Supply Agreements for other data – some of which are currently provided by voluntary agreements
- Energy data revisions indicated in the UK Energy Statistics, and inventory revisions are reported annually to UNFCCC. Could consider more transparent presentation.
- Could there be more clarity in reporting formats?
  - carbon dioxide equivalent is now the UK Government standard
  - source and end-user sectors summaries not always consistent - though national totals add up. Need for greater consistency
  - Considering more user-friendly introduction to National Inventory Report
- UK has established a *climate change statistical co-ordinator* function to ensure that all potential users properly understand the official figures. Are further

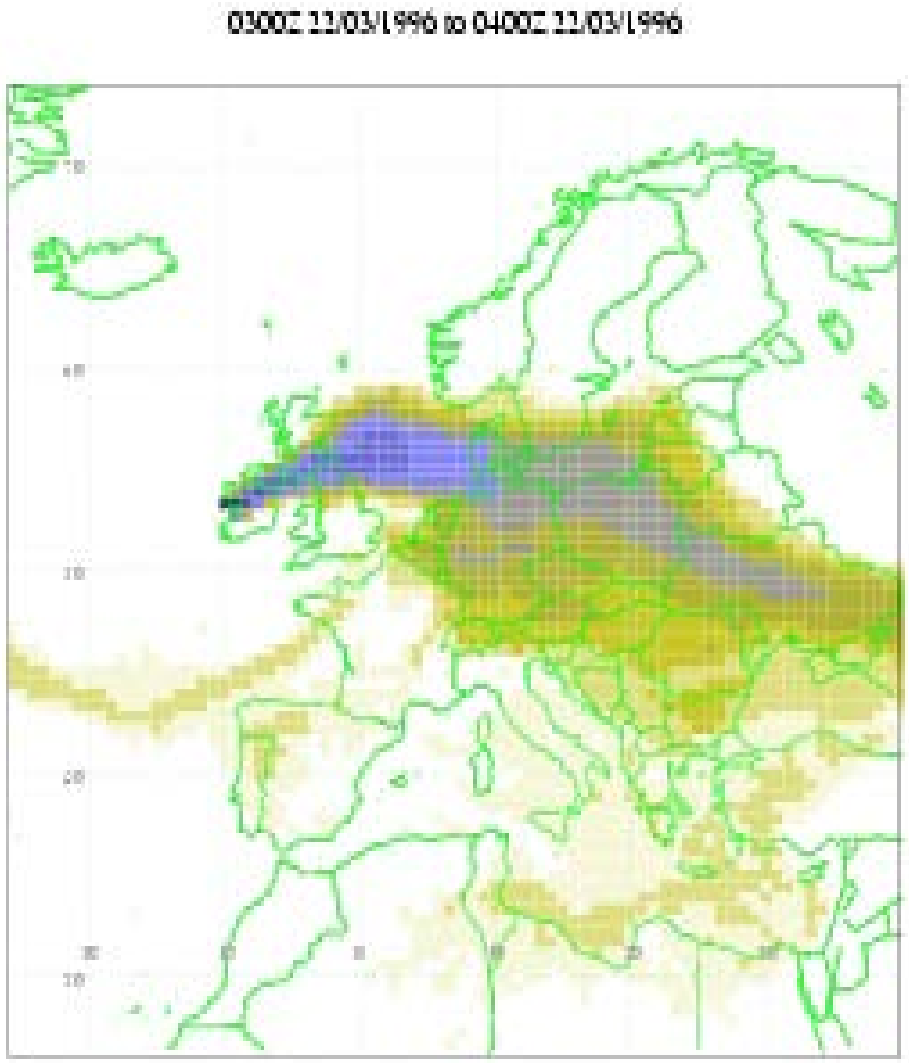
Statistics issues: Fossil fuels data robust, non-fossil sources more difficult

- Fossil fuel consumption known to within 2%: with careful scientific work on emissions factors, CO_2 emissions accurately known
- Domestic and commercial gas and electricity supply now collated at $1km^2$ grid level.
- Regional breakdown of emissions from surface transport more tricky – but national total well known
- Emissions from aviation well known (shipping more uncertain)
- Industrial emissions well reported due to pollution legislation
- Agricultural and land use emissions diffuse and difficult to characterise
- Major challenge to ensure changes in land-use practice are reflected in inventory. In the meantime, policy-makers need to resist the temptation to respond to the need to reduce the inventory results. For example, reducing livestock numbers is unlikely to reduce emissions associated with UK consumption if UK consumption of livestock products remains constant.

Statistics issues:
Importance of validation against observed data

- UK uses atmospheric measurements of GHG concentrations at Mace Head (Ireland)
- Measurements are then put through ‘inverse model’ to identify where gases came from
- Few countries attempt this comparison routinely

N_2O emissions across Europe
(1 hour, one day)



Source : Met Office Report for Defra

Statistics issues: importance of robust sectoral economic data in making judgements on impacts of different mitigation strategies

- Carbon pricing – in particular through the EU emissions trading scheme, but also through carbon taxes and other instruments – a key measure.
- But – as earlier discussion of embedded emissions shows – carbon leakage is an important consideration for policy effectiveness.
- In addition to an understanding of environment statistics, policy makers need to rely on economic data, at sectoral and sub-sectoral level.
- Robustness, timeliness and accuracy of data sets on production, trade, and profitability in key sectors and subsectors will be increasingly important in developing mitigation strategies.
- Policy debate at present is heavily influenced by assertion from different stakeholders: policy-makers will need help in understanding available data and drawing robust conclusions

Impact of carbon pricing on sectors, compared with their exposure to international competition

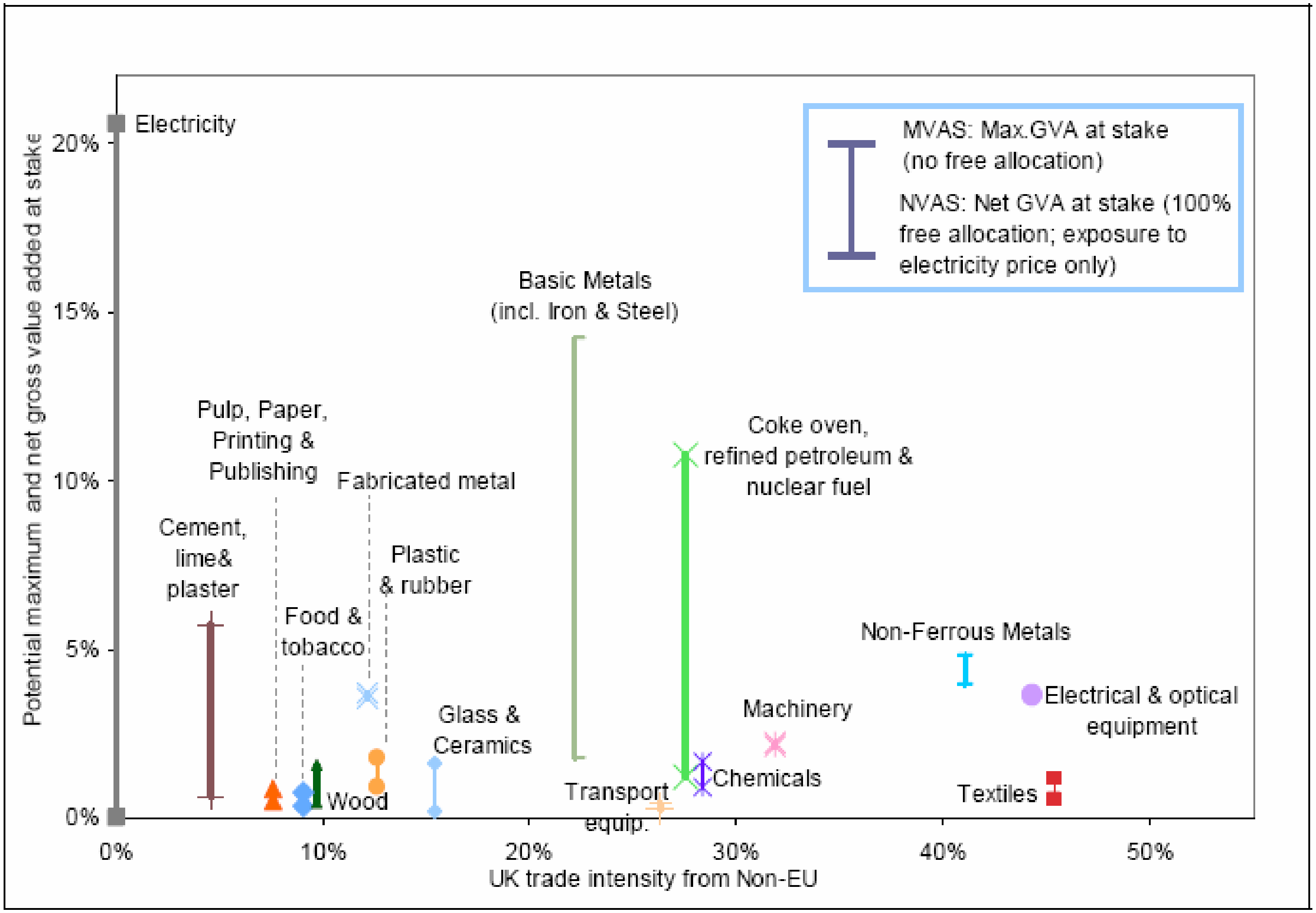
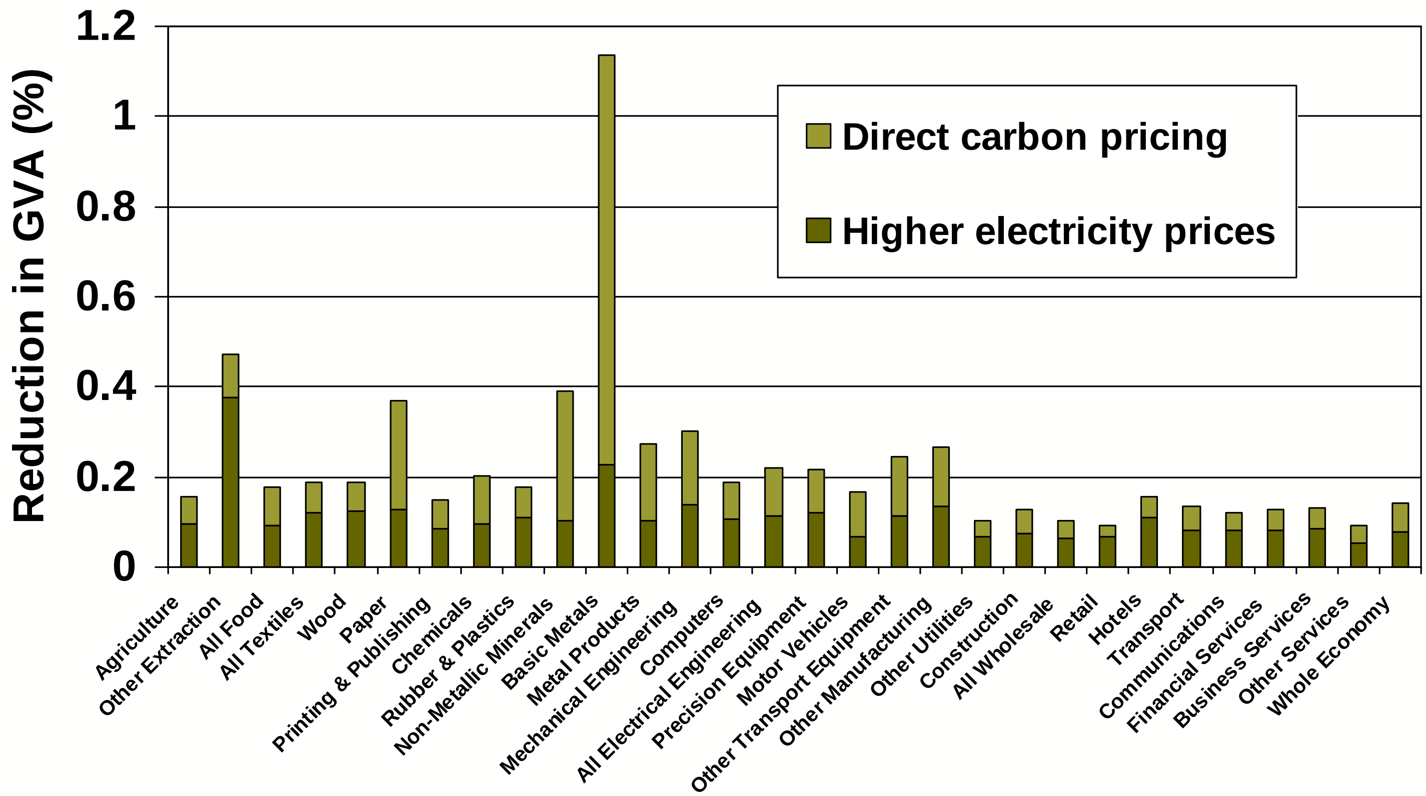


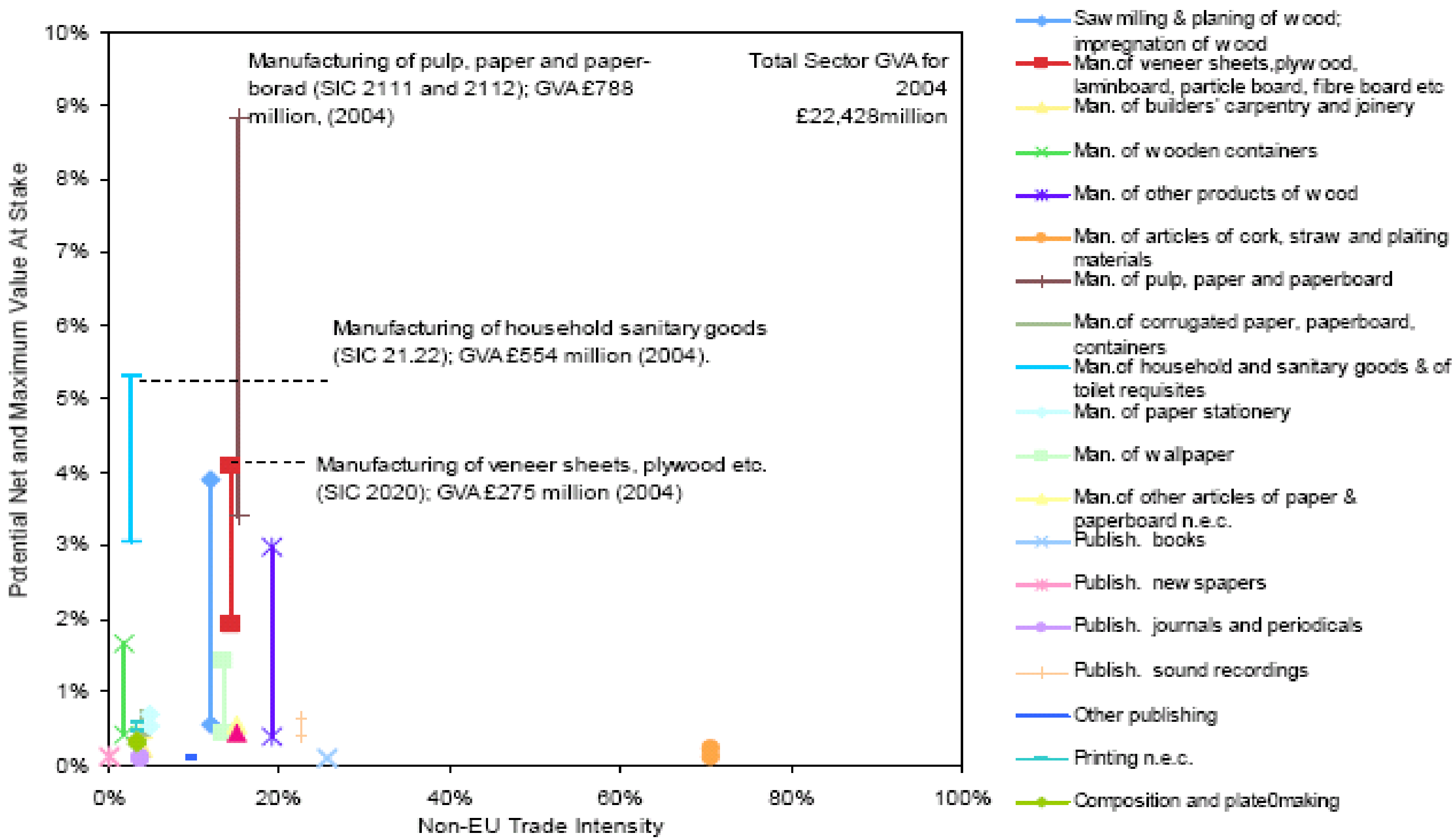
Figure 3 -Value at Stake for main industrial activities, relative to UK trade intensity from outside the EU, for €20/t CO2.

Estimated impacts on competitiveness is small in most sectors at a carbon price of €25/tCO2



Sub-sector analysis (e.g. paper sector) reveals a range of different levels of impact

defra
Department for Environment Food and Rural Affairs



Summary

- UK policy on emissions is set out in a comprehensive **Climate Change Programme**. Current **legislation** before Parliament sets out new high-level process for managing UK emissions.
- UK **inventory methods are robust**, and comply with IPCC guidance. **Political focus**, and **high profile targets**, put the data and targets under **intense political scrutiny**.
- Policy makers need a **clear understanding of the basis** of inventory and other data; and need to promote informed public debate. Particular issues include:
  - Treatment of emissions from **international aviation**
  - Embedded emissions from **net UK imports** of carbon-intensive goods
  - Potential in some sectors (e.g. **agriculture**) for policies aimed at reducing inventory record of GHG emissions to be counter-productive
- Understanding of data needs relating to the **economic impacts** of mitigation options needs to be improved.

Statistical Office Support for Emission Trading Schemes

Developments in Australia

Presented by Peter Harper
Deputy Australian Statistician
Population, Labour, Industry and Environment Statistics Group
Australian Bureau of Statistics

Conference on Climate Change and Official Statistics
Oslo, Norway, April 2008

Session Outline

- Background to an Australian ETS
- Statistical support for the design and implementation of the ETS
- Statistical support for examining the impacts of climate change
- Capturing new economic activity in official statistics
- Measuring the economic, social and environmental impacts of the ETS
- Concluding remarks

Background to an Australian ETS

- Australian Government, through Department of Climate Change, is establishing an ETS
  – Scheme is expected to be implemented in 2010
- Five tests for the ETS
  – Cape and trade, with all major emitters included
  – Must effectively reduce emissions
  – Economically responsible
  – Fair
  – In place quickly

- DCC is being supported by Australian Treasury and the ‘Garnaut Review’
  - Builds on previous work by a PM Taskforce in 2007
- ETS has significant implications for official statistics
  - ABS is working closely with DCC and other key stakeholders

Statistical support for ETS design and implementation

- Economic modelling (CGE) to inform on distributional impacts and assist in design of compensation schemes
- This modelling will be underpinned by I-O tables
- ABS has been funded to upgrade frequency (to annual) and quality of IO tables
  - Implications for IO compilation and collection of source data
  - Positive externality for other economic analysis!
- IO tables will need to be integrated with other information, particularly physical information on energy supply and use
  - Enhanced and higher profile energy accounts

Statistical support for examining impacts of climate change

- Garnaut Review to examine impacts of climate change on Australian environment and economy
  - Will inform emissions ‘trajectory’ that will underpin ETS
  - Will involve a wide range of statistics
  - ABS has been discussing availability and relevance of statistics with Review Team
  - ABS staff member likely to be ‘outposted’ to Review Team

- More generally, ABS produces a range of economic, social and environmental information
  - Support analysis of impacts of climate change
  - Understand adaptations required
  - Understand impact of mitigation
- Notable examples include
  - Water accounts
  - Natural resource management statistics
  - Statistics on agricultural practices
  - Statistics on household environmental behaviours

Capturing new economic activity in official statistics

- Basis of ETS will be tradeable permits
  - Impacts on national accounts, government finance statistics and statistics on market participants themselves
- Particular issue is treatment of permits
  - Dealt with in updated SNA
  - Updated SNA will be introduced in Australia in 2009
  - All Australia's economic statistics use SNA as conceptual base
- Statistics on market activity – eg issuance, price, turnover and acquittals -- will be required

Australian Bureau of Statistics

- Emission market will need to be underpinned by high quality statistics
  - Particular need for regular, high quality statistics on emissions
- Australian Government is upgrading reporting of energy-related information for regulatory purposes by establishing NGERS
- ABS is working closely with NGERS's administration to maximise statistical benefits

Measuring economic, social and environmental impact of ETS

- These impacts will have policy implications, so they need to be understood
- Some of these impacts may precede implementation of ETS
- ABS needs to understand potential for impacts
  - Take into account in determining statistical work program
  - Ensure appropriate methods in place
  - Enable identification of particular ETS impacts wherever possible

- Some statistics that are likely to be affected
  - CPI
  - Household expenditures
  - BOP
  - Capital expenditure
  - R&D and innovation
  - Profit statistics
  - Transport statistics
  - Household and business use of energy
  - Regional statistics
  - Statistics on renewable energies
- Essential for ABS to work closely with key stakeholders to understand statistical requirements

Australian Bureau of Statistics

Concluding remarks

- Design and implementation of ETS has significant statistical implications
  - Some are direct, others are indirect
- ABS has been able to work closely with key policy holders
  - Some additional funding has been received
  - Will need to work in partnership with others to ensure that statistical implications are properly understood and dealt with

Australian Bureau of Statistics

- Tremendous opportunity to show ABS capability
- Issues are complex
  - Require highly-skilled people
  - Will affect many parts of the organisation, so important that there is good internal coordination
- A lot needs to be done in a short period of time, so excellent project management is essential

Supporting Low-Carbon Growth Opportunities in Developing Countries: How Can Better Data Help?

Kseniya Lvovsky
Program Leader, Climate Change

UN Conference on Climate Change and Official Statistics
Oslo (Norway) 14-16 April 2008

Outline

1. Development benefits from low-carbon growth opportunities

2. Where are the data gaps to help capture these benefits?

3. Accessing and leveraging carbon revenues

4. Facilitating and monitoring the use of evolving climate financing

Development Benefits from Low-carbon Growth Options

Greater energy efficiency & diversification of energy base

Increased competitiveness through technological innovation

Improved air quality and reduced congestion

New business and income-generating activities

Access to additional financing (e.g., carbon revenues)

Extending Scope and Improving Reliability of Datasets can help:

Improve understanding of low carbon growth opportunities and develop more reliable projections

- identify multiple benefits and opportunities for sustainable development
- assess mitigation potentials (volumes, incremental costs and co-benefits)
- assess best policy options to facilitate these cost-effective options
- Facilitate and better leverage carbon finance and other climate funds
- understand pros and cons of options discussed at climate negotiations

Monitor progress on the path to a low-carbon growth

- Bali Action Plan: "nationally appropriate mitigation actions by developing countries in a measurable, reportable, verifiable manner"

Towards a WBG Strategic Framework on Climate Change and Development (SFCCD)

To integrate climate change and development challenges, without compromising – and rather enhancing – growth and poverty reduction efforts through:

- country, regional, and global operations
- a multi-sectoral, multi-dimensional approach
- the use of a strong and balanced results framework
- working with other development partners
- resource mobilization in addition to the current ODA levels
- staying neutral to UNFCCC process while representing impacts on developing countries

SFCCD Pillars

1. Make effective climate action – both adaptation and mitigation - part of core development efforts
2. Address the resource gap through existing and innovative instruments for concessional finance
3. Facilitate the development of innovative market mechanisms
4. Create enabling environment for and leveraging private sector finance
5. Accelerate the deployment of existing and development of new climate-friendly technologies
6. **Step-up policy research, knowledge management and capacity building**

On-going WBG initiatives to improve data and capacity

Major existing products: World Development Indicators database, Little Green Data Book, State and Trends of the Carbon Market

Ongoing initiatives in the context of low-carbon growth:

Analytical work

- WDR 2010 on Climate Change
- 6 Low carbon studies (Brazil, China, India, Indonesia, Mexico, South Africa)

Analytical tools & data

- Mainstreaming CC in datasets (WDI, Green Book) & indicators
- C-footprint initiative, to build capacity with staff and clients in understanding GHG implications of WBG operations
- Data portal: GIS dataset with information relevant to adaptation and mitigation

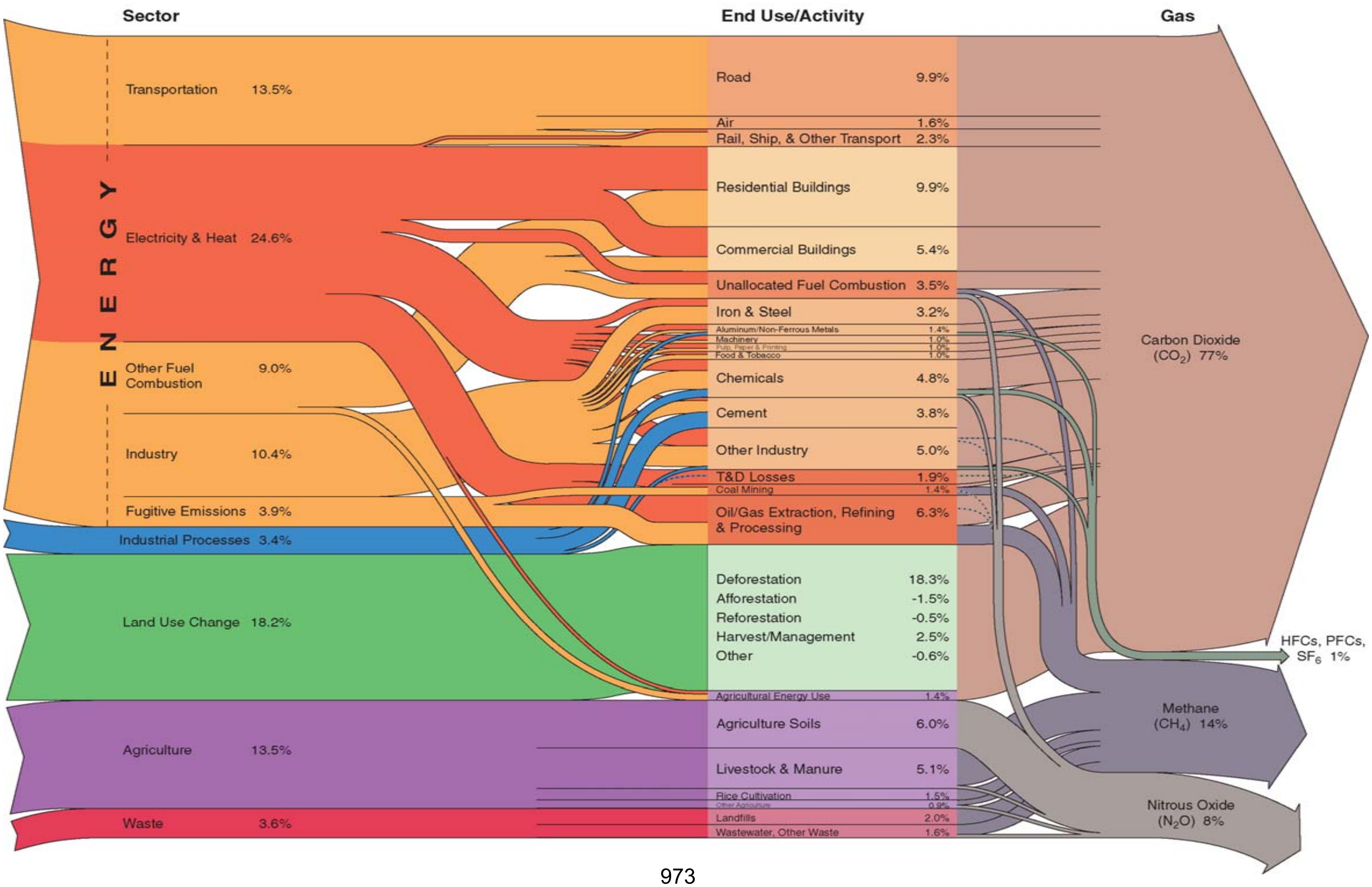
Capacity building

- In the context of country-level programs, such as low-carbon growth studies, EE indicators TA project, etc.
- In the context of innovative financing instruments, such as the FCPF and the CPF (devoted funds)

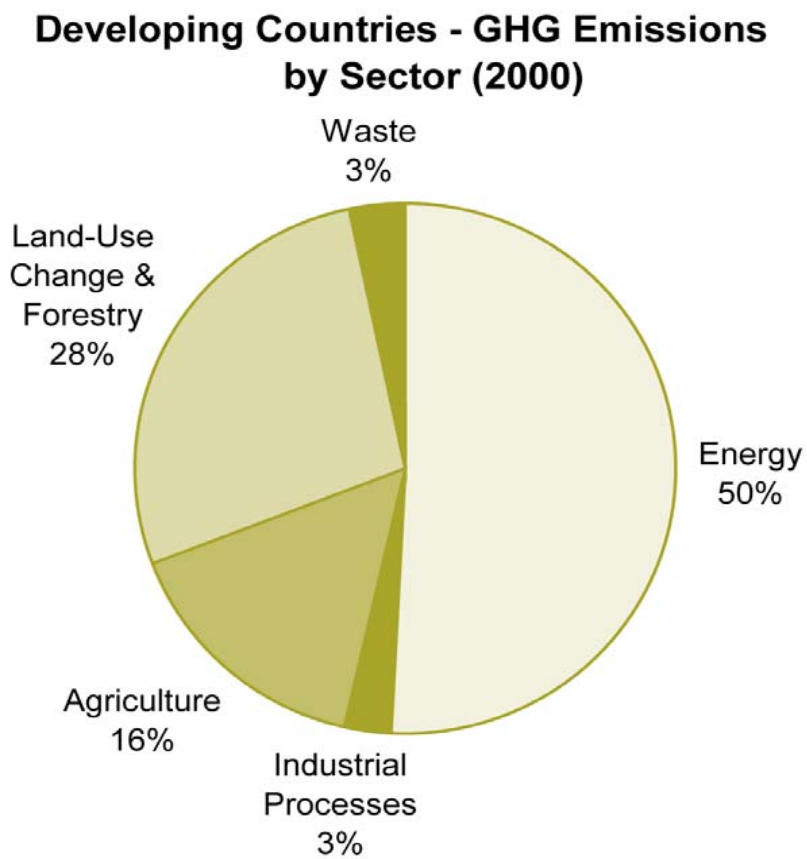
Where are the data gaps?

- **Lessons from WBG Analytical and Operational work** in developing countries points to the importance of strengthening data collection and reporting in the areas of:
  - GHG emissions across all gases and sources
    - National Communications are usually outdated, need more frequent update, reporting and integration with official statistics
  - Technical and economic mitigation potentials per sector
  - Physical and economic data on technologies
  - Financial flows in low carbon technologies
  - Carbon finance
  - Climate-friendly policies and measures
- **Select illustrative examples** follow

Sources of GHG are cross-sectoral



How to grasp major pro-development mitigation opportunities in developing countries?



***Source:* WRI / CAIT.**

Agriculture, Forestry and Land Use (AFOLU) account for almost 50% of emissions in low and middle income countries

Forestation, avoided deforestation and agriculture activities can have significant development benefits, while reducing emissions and enhancing resilience to CC

Still using old (2000) and not very reliable data!

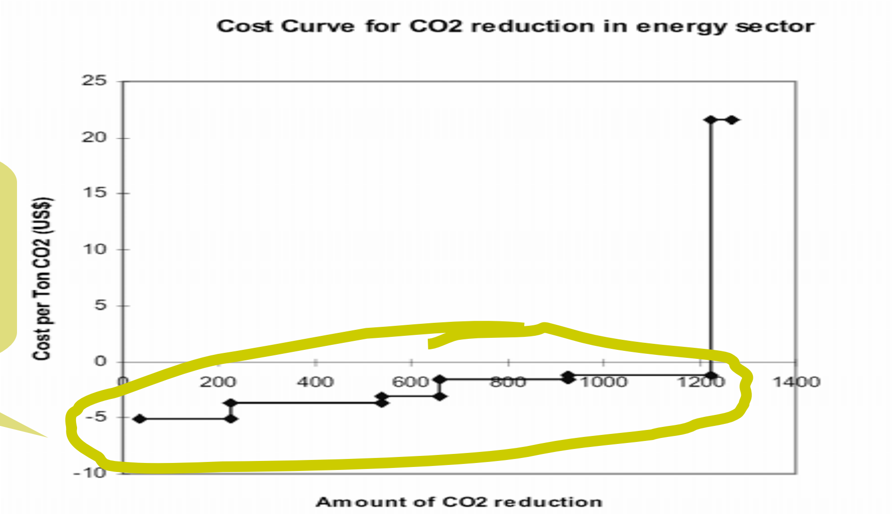
Data gaps (and methodologies) are a significant constraint to access Carbon market for AFOLU activities

- –improve data for land cover (areas, activities, cover type)
- –improve inventories for emissions from AFOLU activities

How to assess cost-effectiveness of key lower carbon options?

Vietnam's Marginal Abatement Cost Curve (MAC), energy sector, 2030

Energy efficiency is a cost-effective mitigation

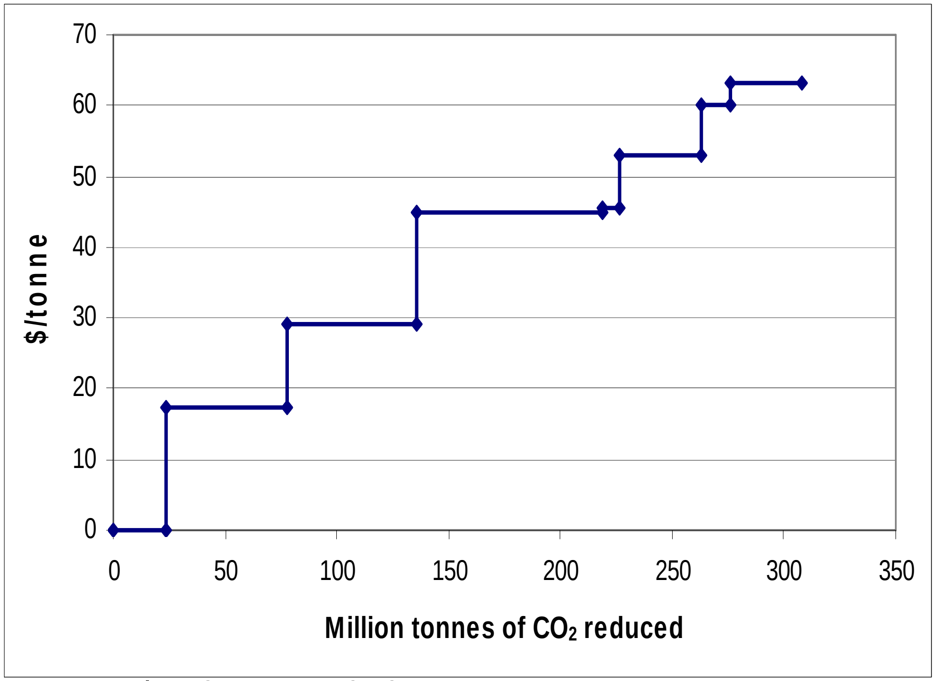


	Option	Amount of CO_2 reduced (Tg)	Cost of CO_2 reduction (US$)
1	Energy efficient Air conditioners	158	-4.42
2	Energy efficient refrigerator	266	-3.60
3	Compact fluorescent lamps	50	-3.38
4	High efficient electric motors	212	-3.02
5	Wind power plant	104	-1.94
6	Efficiency improvement in coal cooking	221	-1.75
7	Fuel Switching in existing thermal power plants	14	21.14

Source: UNEP (1999), Economics of Greenhouse Gas Reduction

..and to better understand cost implications of more expensive options?

India's Marginal Abatement Cost Curve, Power Sector, 2012-17



Source: Planning Commission

No.	Technology	Mitigation cost ($/ tonne)
1	Renovation and modernization	-ve
2	Coal ultra supercritical	17.4
3	Small hydro	29.1
4	IGCC based on Imported Coal	45.0
5	H-frame CCGT	45.4
6	IGCC based on Indigenous Coal	52.9
7	Biomass gasifier	60.0
8	Wind turbine	63.2

Major data gaps to devise effective programs for Energy Efficiency

- **Data needed for** the national low carbon growth strategies includes:
  - The pool of **appliances** (cook stove, TV set, heating/cooling unit...):
  - numbers and **efficiency** of these appliances
  - **costs** of upgrading
  - **housing** (share between old buildings – to be refurbished; new buildings – fortunately built along new standards; rate of ownership),
  - SMEs
  - **transport** (modal share, size and efficiency of fleet)

Examples of data needs to assess low carbon opportunities in the power sector

- Plant data
  - Updated Inventory of operating plants.
  - Proposed and planned new plants
- Extensive survey data on all sectors of the economy (industry, commerce, institutional, households, agriculture, etc.)
  - Current level of activity and future forecasts including changes in import/export of goods and activities
  - Total electricity usage
  - Energy usage from other fuels and off-grid
  - Appliances used: hours per day, efficiency, capacity, power consumed, technology level
  - Maintenance, rehabilitation and replacement programs; investment, timing, and expected efficiency/capacity improvements
  - Additional possibilities to improve efficiency/capacity showing investment, timing and expected efficiency/capacity improvements
  - Future trends in new appliances: energy consumption, efficiency, expected up-take, replacement of existing appliances
- Pricing/taxation measures and expected impact on demand
- Expected changes in the overall economy and impact on each sector

How to better access and leverage carbon revenues?

The State and Trends of the Carbon Market:

Issued by WBG since 2001, to **monitor and analyze** the activity of the global Carbon Market, with a **focus on the CDM and JI Markets**

- volumes transacted, prices and contract provisions
- projects types and host countries
- origin and profile of buyers
- major trends

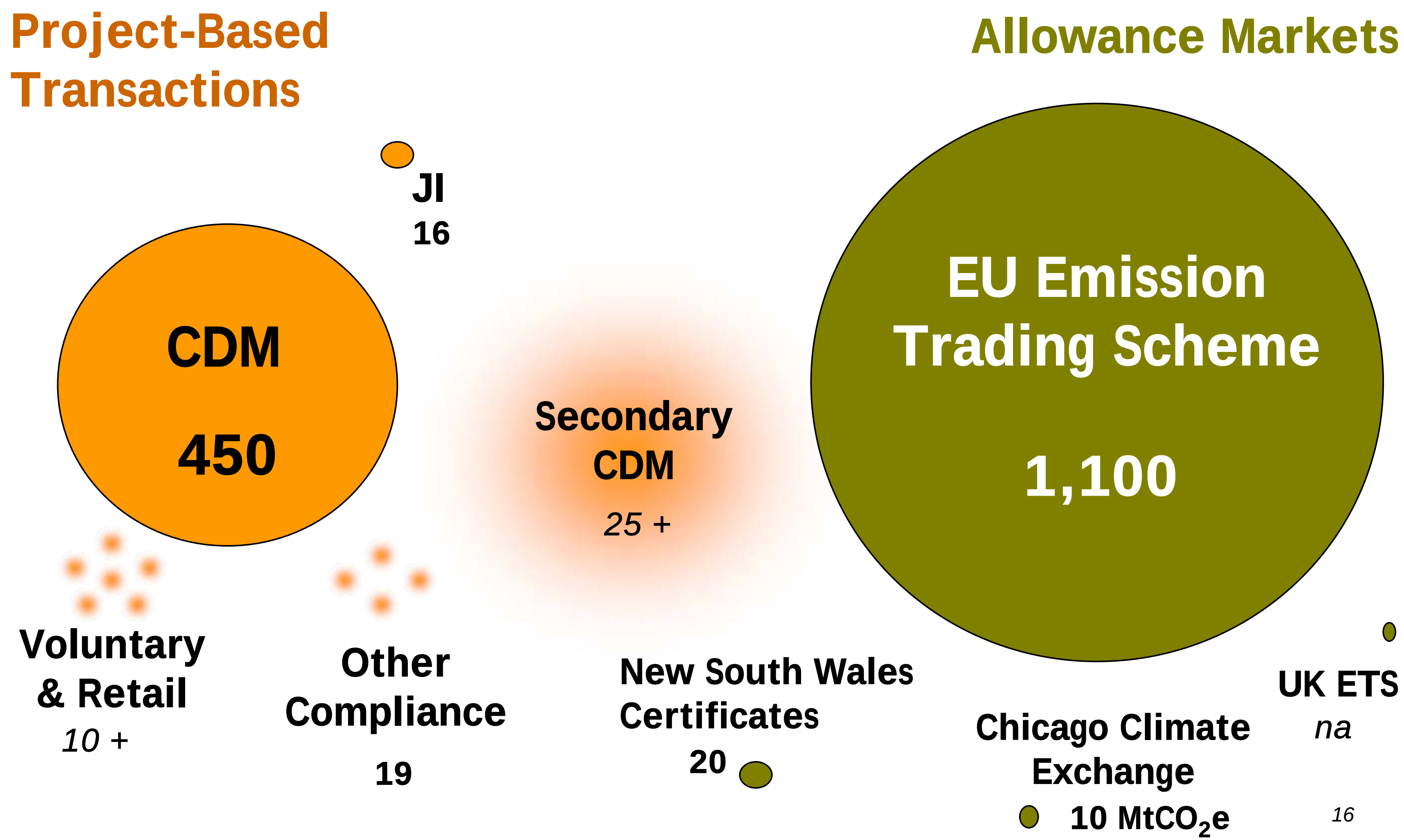
Significant data collection effort through interviews with market-players (natural buyers (Europe & Japan), fund managers, developers, sellers, DNAs, private equity funds, hedge funds, banks, traders & brokers), and a survey of carbon-related information (academic and professional literature)

Widely used for capacity-building in host countries by the CF-Assist program (WBI): downloaded > 15,000 times in 06

Next issue to be launched at Carbon Expo 2008, 7 May 08

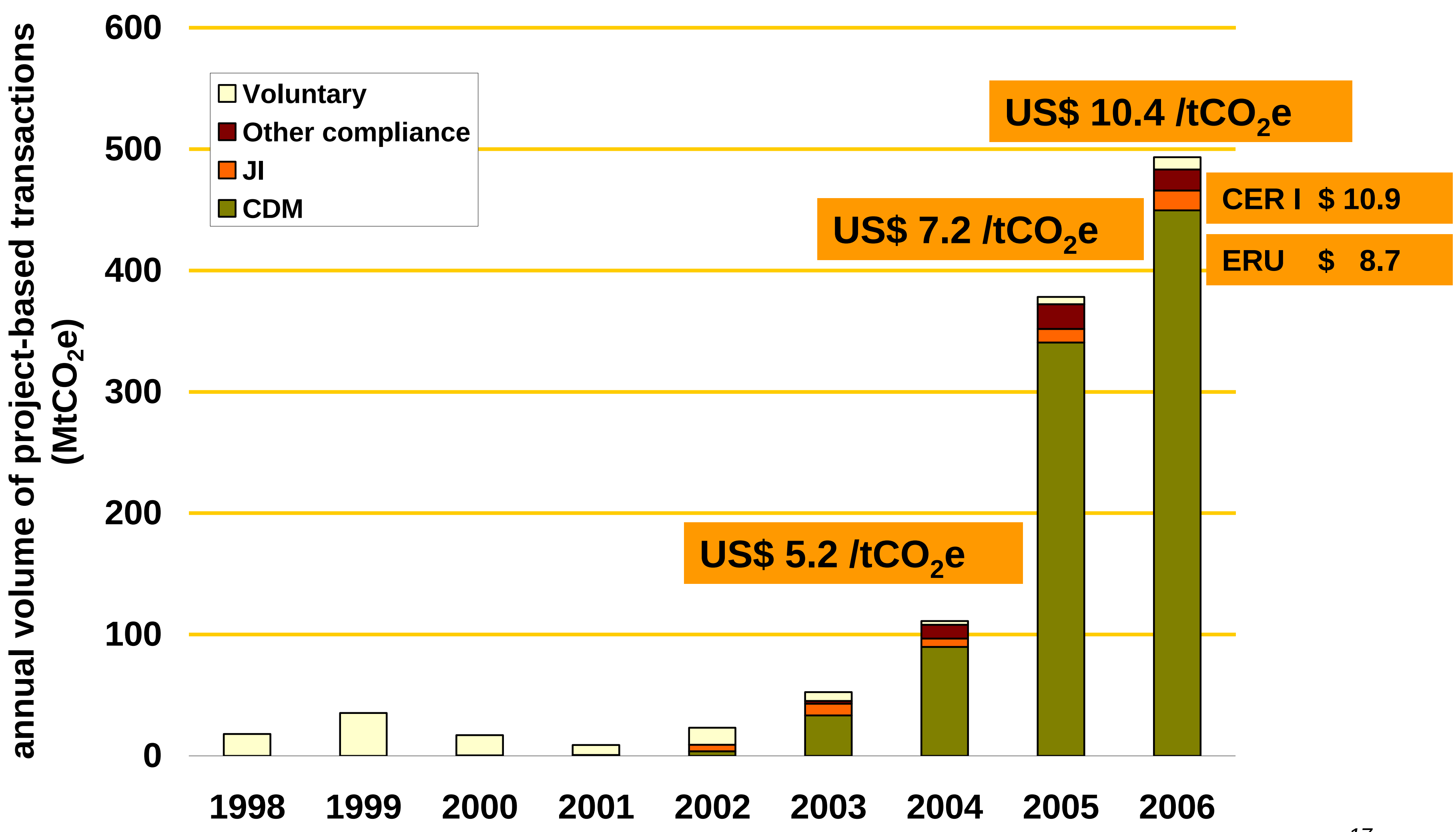
www.carbonfinance.org

A Rapidly Growing Market
(volumes transacted in 2006, in $MtCO_2e$)



16

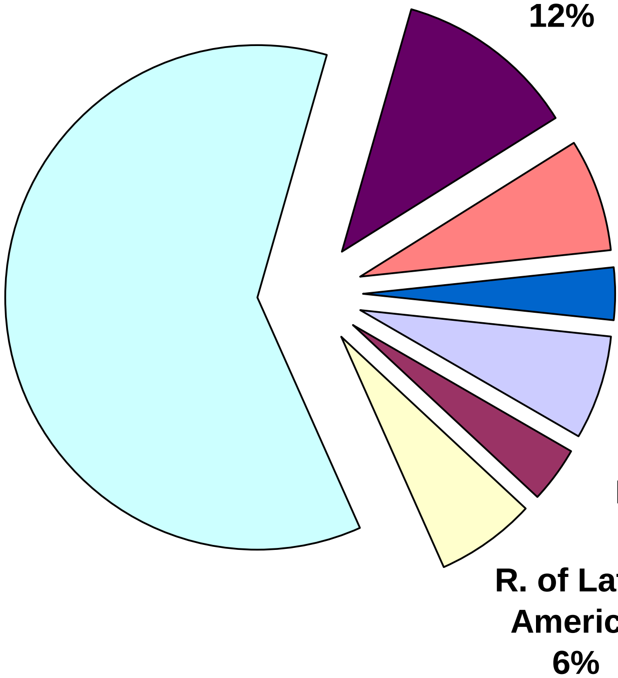
Prices & volumes up for project-based credits

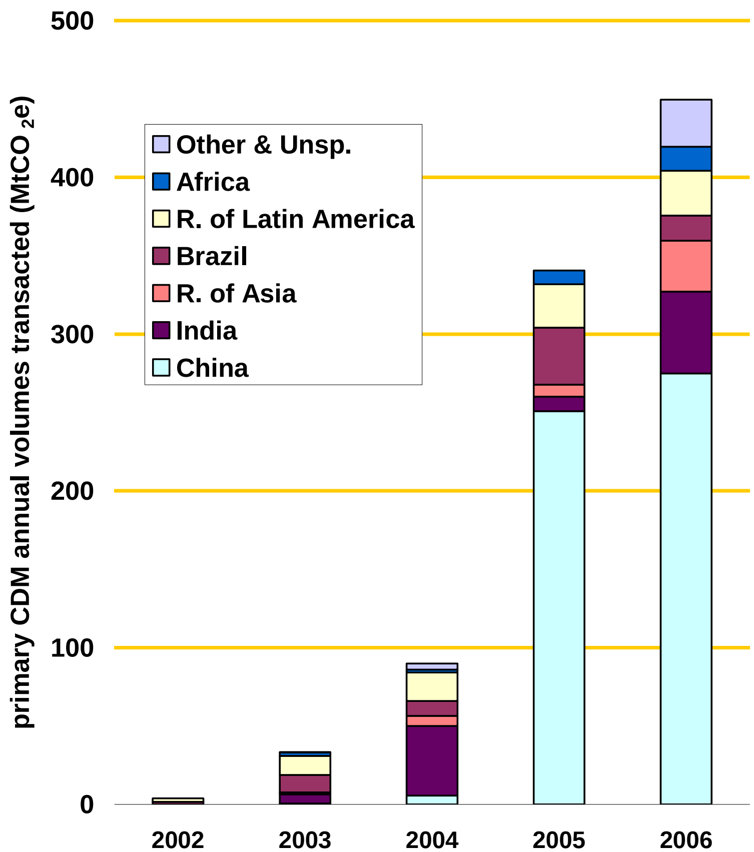


17

CDM Sellers
China leads supply

(share of volumes)

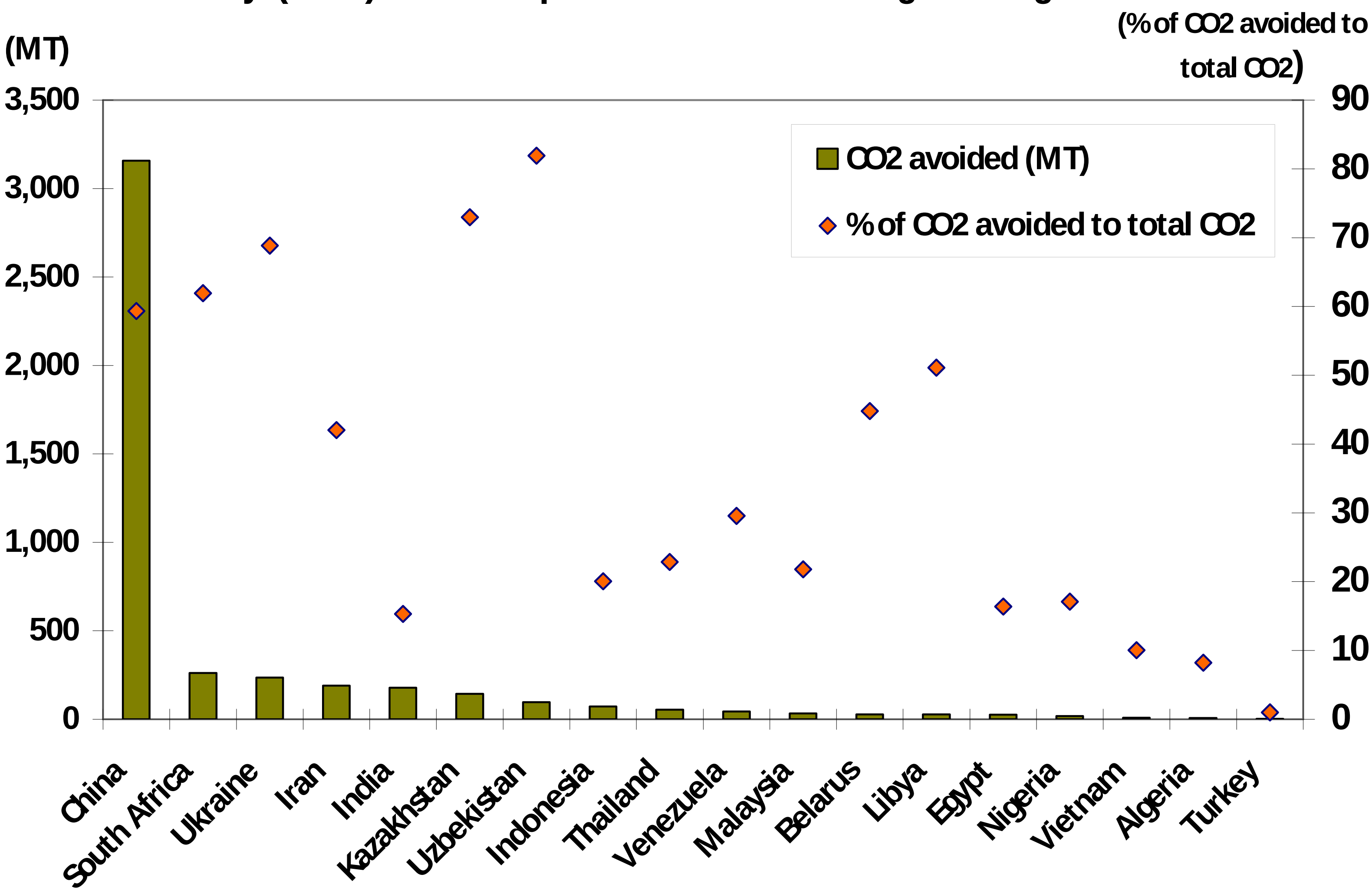




Jan. 2006 to Dec. 2006

Compare with where biggest reductions could occur …

Potential CO2 emissions avoided in ODA-eligible countries in 2005 if C-intensity (PPP) were improved to the average of high income countries

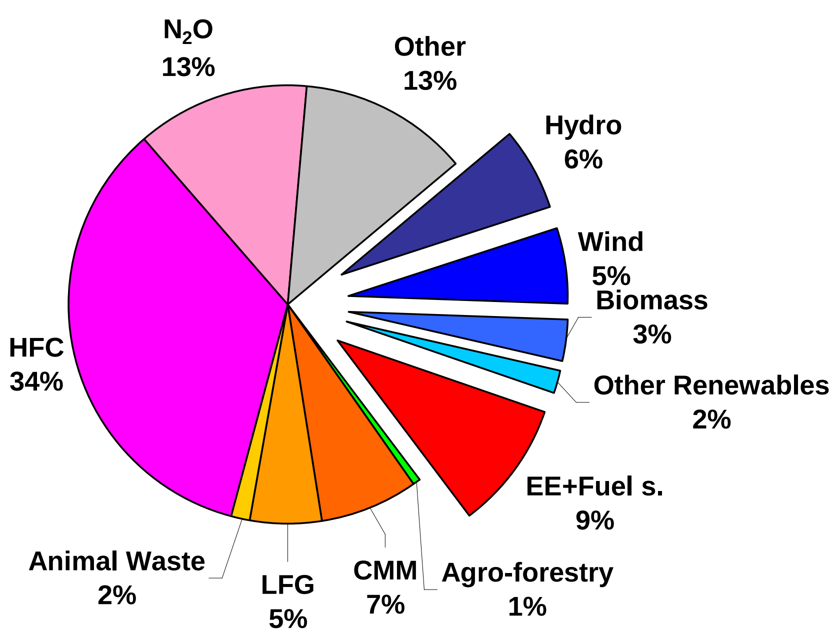


CDM Asset classes

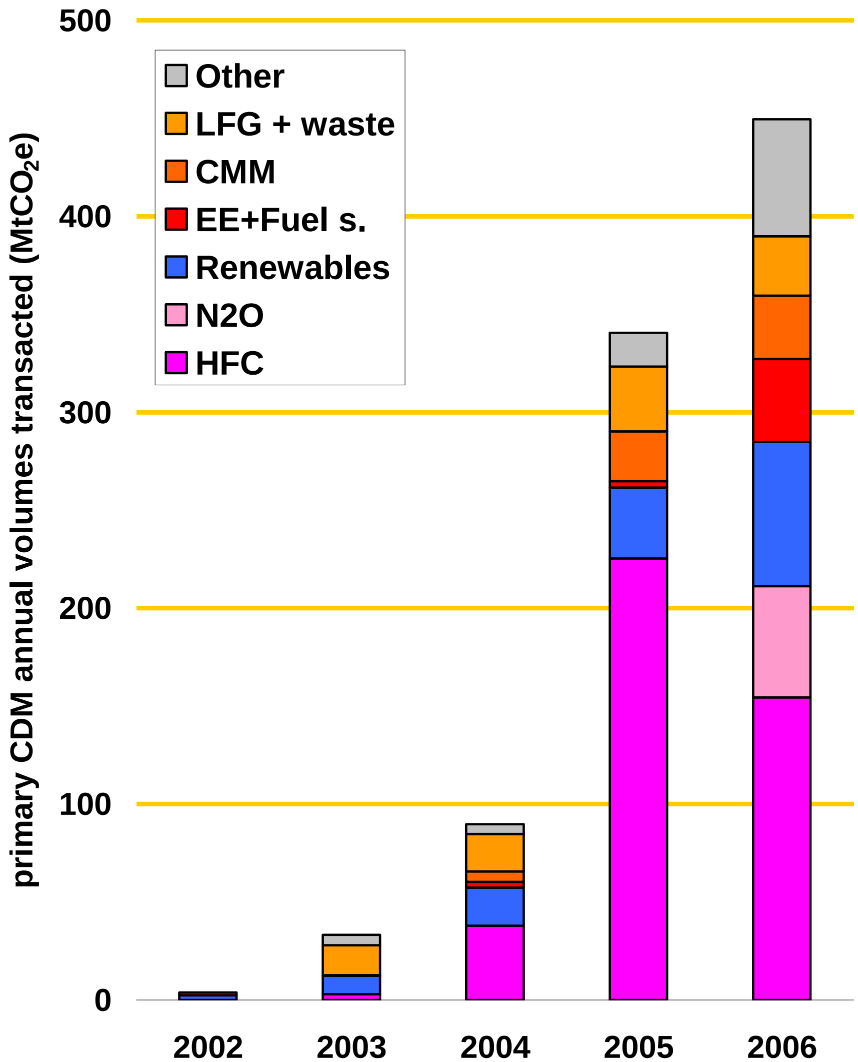
Share of Clean Energy Rises

(share of volumes)

Clean energy: 25%



Jan. 2006 to Dec. 2006



20

The development dividend

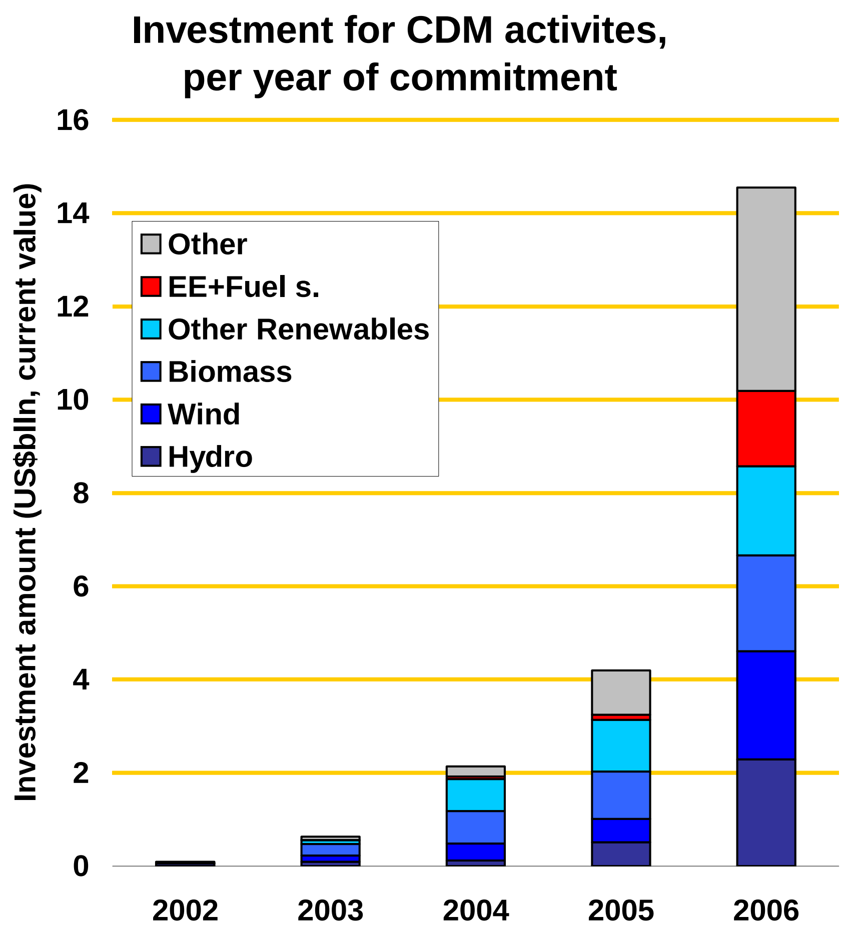
Cumulative CDM deals = US$ 7.8 billion, leveraging about US$ 22 billion capital.

US$ 16 billion leveraged for clean energy in developing countries since 2002 (of which US$10 billion in 2006).

US$ 21 billion invested for clean tech in developing countries in 2006.

Significant contribution of CDM vis-à-vis clean energy investment in developing countries

Not to the scale of what is needed to tackle mitigation (US$ 110 billion per yr.)



21

Facilitating Carbon Finance

- Statistical gaps and lengthy and costly collection processes are among the barriers to more projects development
- Making data available at country level (w/possible regional breakdown) in collaboration with host countries could facilitate:
  - streamline **baseline** (e.g., grid emissions factors),
  - make **benchmarking easier,**
  - compute **deforestation baseline.**

Taking advantage of new climate financing instruments: directing to right areas, leveraging, monitoring, etc.

- Forest Carbon Partnership Facility (FCPF)
- Carbon Partnership Facility (CPF)
- Climate Investment Funds (CIF) – a joint initiative of MDBs
- MIGA –use of guarantees for carbon credit delivery
- IFC- Structured financing packages blending CF with loans and guarantees
- WB Treasury - bonds at reduced rates to advance to projects with climate benefits
- Financing programs by the MDBs and UN agencies have

Measure financial flows

- UNFCCC estimates that by 2030 financial flows to developing countries should be on the order of $100 billion annually to finance mitigation (80% from private sector)

- Need to quantify:
  - investments flows in low-carbon technologies, with public/private breakdown, and foreign/domestic origin,
  - in particular with a link to carbon finance (what is the actual leverage of CF?, how can it be augmented?).

More quantitative information on the national policy front

There are **many leverages to a sustainable low carbon actions**:

- win-win instruments: e.g., rationalizing subsidies, using "green" taxes, energy efficiency standards, consideration of climate financing in public funding.
- enabling environment to direct investments and financial assistance into low-carbon activities, including improved governance and fiscal responsibility.

Statistical implications:

- complement data on tax revenues/subsidies expenditures on energy and other goods and services, with a *breakdown* between C-intensive ones and climate-friendly ones.
- prepare review (and update) similar to IEA's Energy Policies of IEA countries
- show *development* benefits (e.g., # of people electrified through leaner energy, savings from EE appliances, etc.)

Concluding remarks

Harmonize and extend data collection relevant for low carbon growth, building on existing national programs:

- Key fields: GHG emissions, physical and economic data on technologies, financial flows, and policies and measures
- Agree on key variables & harmonize definition
- Link to indicators capturing the development dimension (e.g., # of people served)
- Integrate around existing platforms and datasets

UNITED NATIONS

Conference on Climate Change and Official Statistics

China's National Climate Change Programme

Xu Huaqing

15 April 2008,Oslo

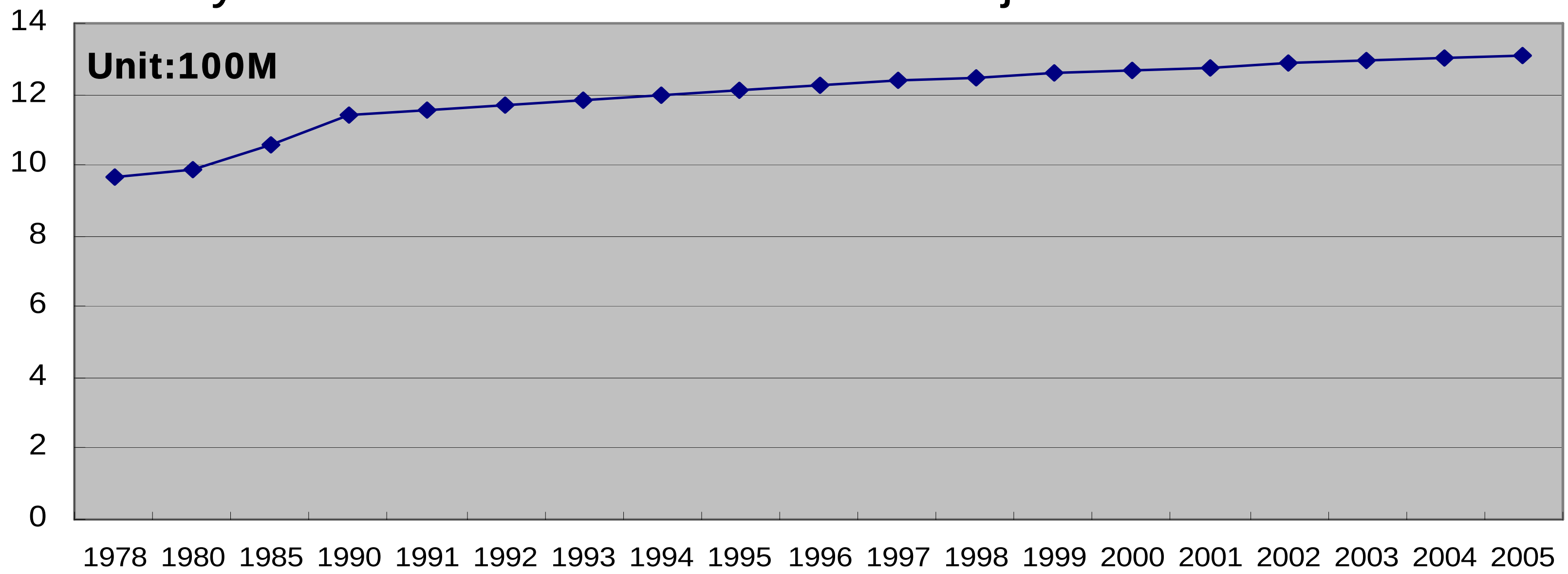
Outline

- National Circumstances
- Principles and Objectives
- Policies and Measures
- CNPCC and the Official Statistics

National Circumstances

1. Huge population & high employment pressure

- By the end of 2005, the total population in Mainland China was 1.31 billion, accounting for 22% of the world total, 750 M people still live in villages;
- Every year, 10 M new employment opportunities need to be created in cities/towns, and about 10 M people living in countryside move to cities/towns to find job.

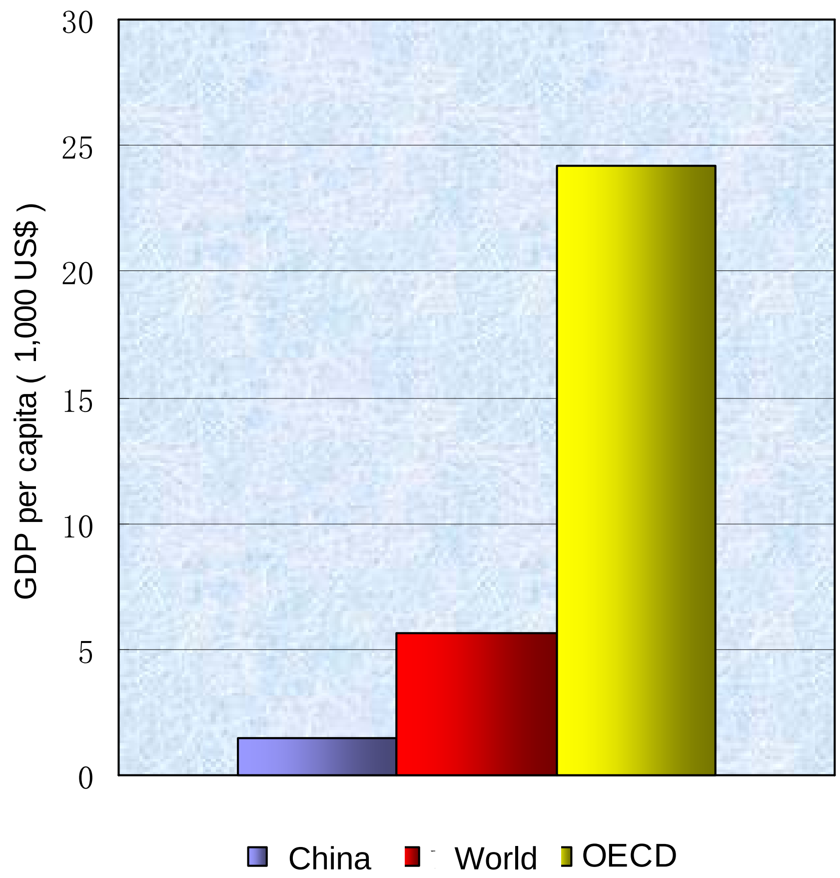


National Circumstances

2. Low level of economic development

- The GDP per capita of China in 2005 was USD 1,714 (based on exchange rate of that year), only ¼ of the world average;
- By the end of 2005, the annual per capita income of 23.65 million people living in villages was less than 683 RMB (USD 83).

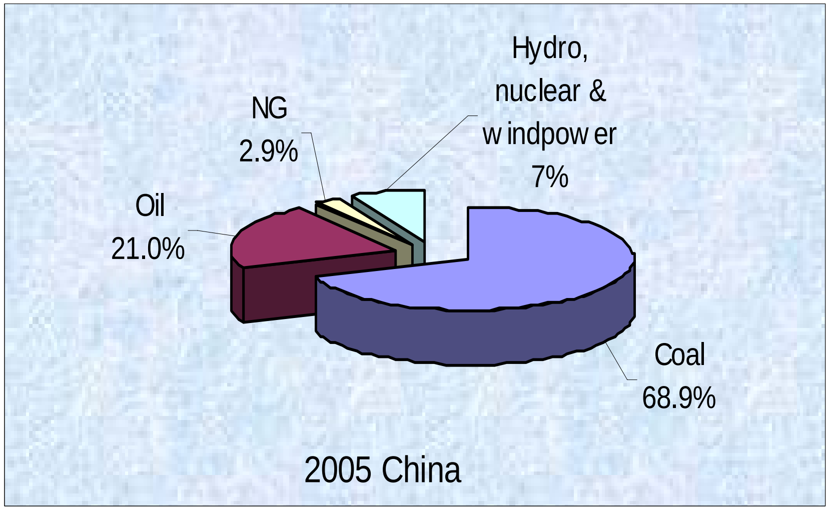
Per Capita of GDP in 2005

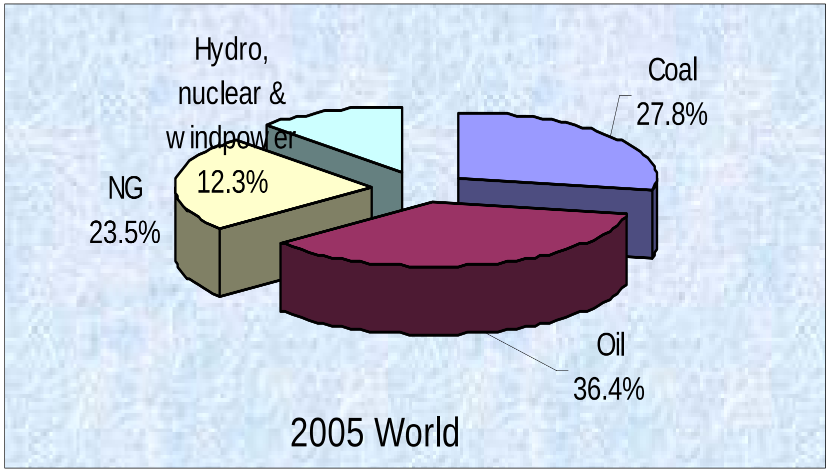


National Circumstances

3. Coal-dominated energy mix

- The primary energy consumption in 2005 was about 1,563 million toe, among which 68.9% came from coal;
- In 2005, coal accounted for 27.8% of the world's primary energy consumption.



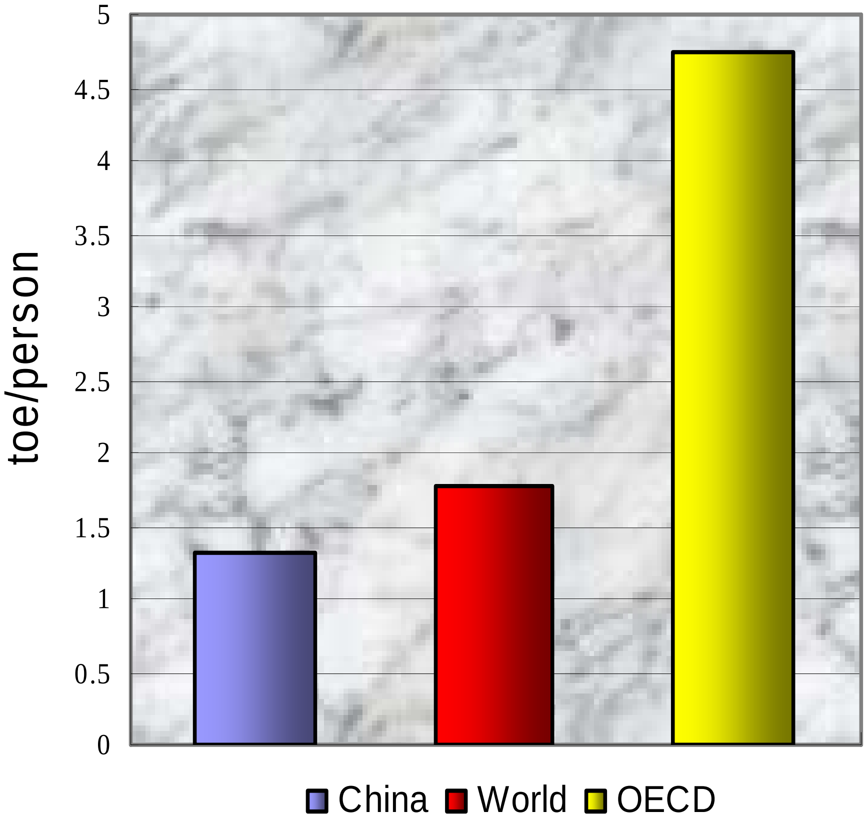


National Circumstances

4. Low per capita energy consumption

- In 2005, the commercial energy consumption per capita was about 1.3 toe, equal to 3/4 of world average and ¼ of the OECD countries.

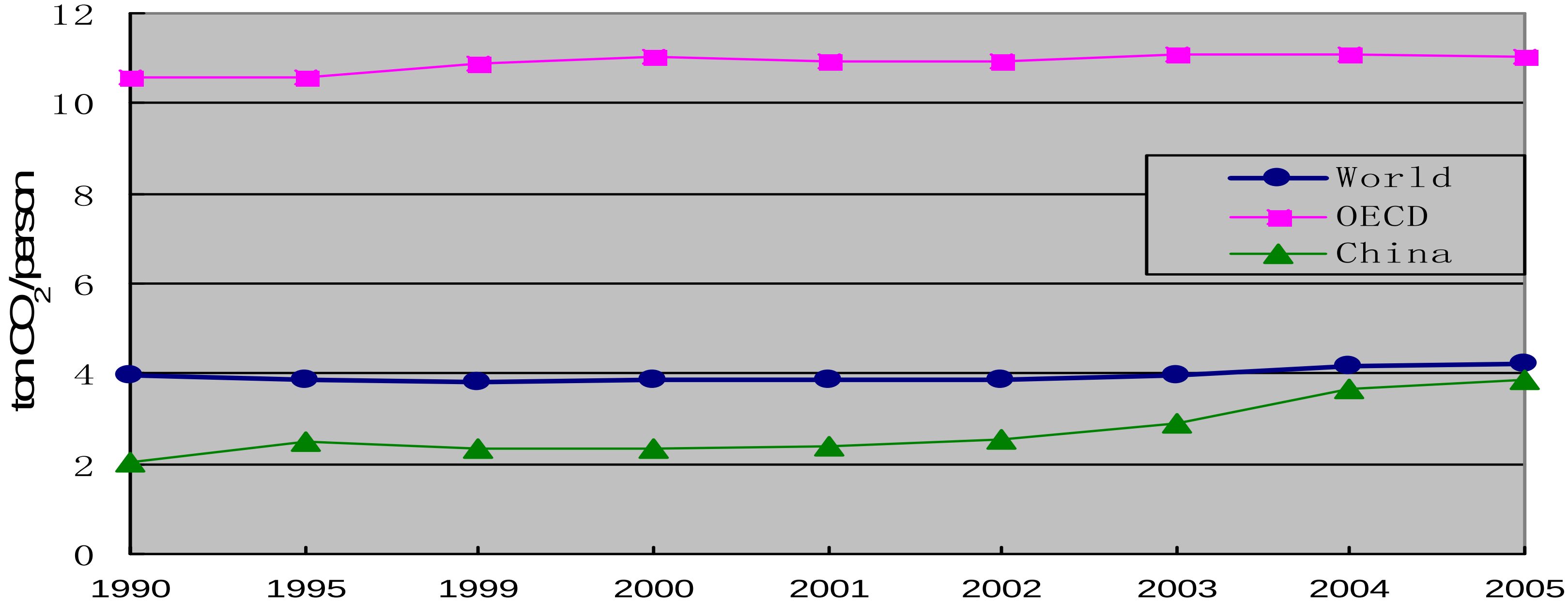
Per Capita TPES in 2005



National Circumstances

5. The CO_2 emission per capita of China is lower than that of the world average

- In 2005, the CO_2 emission per capita of China from fossil fuel utilization was 3.88 tons, equal to 92% of the world average and 35% of the OECD countries.



Principles and Objectives

1. Guiding Principles:

- Addressing climate change within the framework of sustainable development;
- Equal importance of mitigation and adaptation;
- Integration of climate policy into other relevant policies;
- Reliance on technological progress and innovation;
- Common but differentiated responsibilities;
- Active participation and broad cooperation.

Principles and Objectives

2. Overall Objective:

- Make achievements in controlling greenhouse gas emissions;
- Enhance adaptation capacity;
- Make new progress in advancing science and technology R&D;
- Remarkably raise public awareness;
- Further strengthen institutions and mechanisms.

Principles and Objectives

3.Objectives by 2010:

- Reduce energy consumption per unit GDP by 20%;
- Increase the share of renewable energy to 10% in primary energy supply;
- Stabilize nitrous oxide emissions from industrial processes at 2005 level;
- Control the growth rate of methane emissions;
- Increase the forest coverage rate to 20%; and
- Increase carbon sink by 50 million tons over 2005 level.

Policies and Measures

1. Promote 10 key energy conservation projects

- Renovation of coal-fired industrial boilers;
- District CHP;
- Waste heat and pressure utilization;
- Oil conservation and switching;
- Motor system conservation;
- Energy system optimization
- Building energy conservation;
- Green-lighting;
- Energy conservation in government agencies;
- Energy saving monitoring and technical service.

Estimated 550 Mt CO_2 emissions to be avoided by 2010

Policies and Measures

2. Develop hydropower

- Hydropower is a key measure towards a low carbon energy structure;
- Together with environmental protection and migration, develop and use hydropower resources in a rational manner;
- Accelerate the development of hydropower and small hydro based on local conditions.

Estimated 560Mt CO_2 emissions to be avoided by 2010

Policies and Measures

3. Promote nuclear power

- Nuclear energy is a key element in national energy strategy;
- Guideline: self-sufficient, international cooperation, technology introduction, domestic built;
- Common technology route and adoption of advanced technologies;
- Achievement of domestic development and production of large scale unit.

Estimated 60Mt CO_2 emissions to be avoided by 2010.

Policies and Measures

4. Optimize thermal power development

- Develop 600+MW supercritical (ultra-supercritical) units;
- Start the IGCC power station project;
- Develop natural gas power generation;
- Acceleration of the elimination of small coal-fired power generators;
- Strengthen power grid construction.

Estimated 110 Mt CO_2 emissions to be avoided by 2010.

Policies and Measures

5. Promote coal-bed methane utilization

- Coal-bed methane investigation, development and utilization should be adopted as important instruments to expedite the structural optimization of coal industry, reduce coal mining accidents, improve resources utilization efficiency and prevent environmental pollution.
- Exempt or partly exempt coal bed methane projects from utilization fees for prospecting and mining rights;
- Adopt preferential tax policies for coal bed methane projects;
- Encourage coal bed methane CDM projects.

Estimated 210 Mt CO_2 eq emissions to be avoided by 2010.

Policies and Measures

6. Development of wind, solar and geothermal energy

Together with the development and construction of large scale wind power plants, to:

- Actively develop photovoltaic and solar heating utilization;
- Actively promote the development and utilization of geothermal and tidal energy.

Estimated 70 Mt CO_2 emissions to be avoided by 2010.

CNPCC and the Official Statistics

National Leading Group to Address Climate Change (NLGACC):

- The Leading Group will be responsible for deliberating and determining key national strategies, guidelines and measures on climate change, as well as coordinating and resolving key issues related to climate change;
- National Bureau of Statistics of China (NBSC) is a member of the NLGACC.

CNPCC and the Official Statistics

The national inventory agencies need to work closely with the NBSC:

- It is good practice to consult with NBSC and seek their advice on which method is the most complete and accurate indication of activity data;
- The most important measure is that official statistical data were used wherever possible;

CNPCC and the Official Statistics

- China Energy Statistical Yearbook and China Statistical Yearbook on Environment as a good base of the activity data for development of the national emissions inventory;
- Uncertainties introduced by the nature of the statistical databases;

CNPCC and the Official Statistics

The Programs for Statistics, Monitoring and Appraisal of Energy Saving as a good base for assessment nationally appropriate mitigation actions in a MRV manner:

- Implementation Program for the Statistical Index System for Energy Consumption Per Unit GDP;
- Implementation Program for the Monitoring System for Energy Consumption Per Unit GDP;
- Implementation Program for the Appraisal System for Energy Consumption Per Unit GDP.

CNPCC and the Official Statistics

Capacity building needs:

- Establishment of statistical system catering to the compilation of emission inventory;
- Methodologies for inventory quality control, assessment of adaptation;
- Projection of future emissions;
- Development and management of national greenhouse gas emission database.

Thanks！

How can official statistics support the IPCC's work?

Dennis Trewin

Statistical Consultant

Structure of Presentation

- Background to IPCC's work
- Key statistical inputs into their models
- Some (statistical) criticisms of the Fourth Assessment Round
- Key areas where official statistical community can assist
- A suggested way forward

Definition of Official Statistcs

- Includes statistical offices within Ministries
- Includes international agencies
- Excludes statistical modellers working at research institutes

Climate Change Scenarios

- A1 - very rapid economic growth, global population peaking in mid century, economic convergence, rapid introduction of new technologies
- A1FI – fossil intensive
- A1T – non-fossil energy sources
- A1B – balanced

- A2 – heterogeneous world, regional based development, continually increasing population

Climate Change Scenarios

- B1 – Similar to A1 but change towards a service and information economy with reductions in material intensity

- B2 – Similar to A2 but population increases at a slower rate and intermediate levels of economic development

Key Variables in Scenarios

- Economic Growth
- Population Growth
- Energy Intensity
- Carbon Intensity in Energy Used

Statistical Criticisms of Fourth Assessment Round

- Economic Growth Rates too high because of non-use of PPPs and assumption of economic convergence
- Population Growth Rates too high

Why does it matter?

- Need best possible evidence base to support analysis of impacts, and to assess adaptation and mitigation strategies

Where might official statistics assist?

- Population Projections
- Economic Growth Projections
- Application of Purchasing Power Parities
- Energy Use and Carbon Intensity Statistics
- Land Use/Cover Data
- Assessing cost of emission strategies

A Way Forward

- Involve an experienced official statistician in the development of the climate change scenarios

Conference on Climate Change and Official Statistics

Oslo, 14 to 16 April 2008

United Nations Economic Commission for Europe
Statistical Division

What role for official statistics: provider of statistical services, or more?

Heinrich Brüngger

Director, Statistical Division

United Nations Economic Commission for Europe, Geneva

Results of Official Statistics (OS)

❖ At national level, results of OS are characterized by:

1. They are produced and disseminated in full compliance with the UN Fundamental Principles of Official Statistics or the EU Code of Practice
2. Conceptually, i.e. concerning definitions and classifications used, they are in compliance with internationally adopted standards of official statistics

Results of Official Statistics (ctd.)

3. Quality in terms of accuracy, timeliness etc. is ensured through applying professionally sound methodologies of data collection and processing, as well as through a regular quality ensurance process

4. Elements of modelling are allowed, but all assumptions have to be verified periodically against representative statistical information, and adjusted. As a consequence, OS producers at national level have generally refrained from publishing quantitative scenarios for future developments (exception: demographic and demographically based scenarios) as results of OS proper

Statistical Services rendered by Producers of Official Statistics

- Condition 3 is the same as for results of official statistics
- Condition 2 is replaced by concepts and breakdowns defined by one single user, or for one specific purpose. The responsibility of the producer of official statistics is not engaged
- As a consequence, it may not be possible to respect some of the UN fundamental principles (condition 1; but confidentiality and transparency are not affected)
- Condition 4 is entirely left to the user

Condition 2 (Standards of OS)

- Concepts used in standards of official statistics are based on a bundling of needs expressed and/or anticipated for various user groups and the public (citizen's entitlement to information); they respond to a multi-user framework

- Concepts used in statistical services can be described as a single user or single purpose framework

- Statistical standards have to be adopted by a recognised authority of official statistics working under the umbrella of professional independence

OS and ICPP

- So far ICPP has been a specific use of statistics (not only OS), with five components:
  - Results from international official statistics taken over directly from IOs
  - Results from national OS that could be taken over directly into the national inventory
  - Substantial component of statistical services following the ICPP manual where it deviates from concepts of OS, and using unit-level data from OS
  - Some additional data collection by producers of OS for the specific purpose of the national inventory
  - Use of data sources from outside OS

OS and ICPP (ctd.)

- With the possible of exception of a few countries, the results of this statistical work do not (yet) have the status of results of official statistics, neither at national nor at international level, because of the absence of standards of official statistics (and because of intensive use of modelling based on expert opinions)

- Official statistics on emissions and climate change are not the only area where there is a lack of standards of official statistics at international level; this is the case also for most other parts of environment statistics (with the exception of water), and some areas of social statistics

Can the present process of using OS for ICPP be improved?

- In certain cases (e.g. PPPs), there a more relevant elements from official statistics that could be used in the IPCC
- Use ISIC/NACE as classifications of economic activities
- Use demographic scenarios produced by national official statistics
- Take knowledge of OS producers (national and international) for aggregating national data to global or continental information (issue of weights is not trivial)
- NSOs have accumulated substantial skills in data integration and analysis; tap this source of knowledge
- Give overall responsibility to NSO (like Finland); this should include coordination of inputs from other producers of OS and from outside OS

Beyond the present cooperation model: what could OS add?

- Make statistics on emissions part of the regular production and dissemination process of official statistics at national level:
  - Spatial allocation of emissions (especially from transport) has to be based on less simplistic assumptions to become representative for national (and possibly sub-national) territory
  - Certain assumptions on conversion factors have to be backed by empirical evidence (changing technologies and different implementation speeds of cleaner technologies)
  - Results have to be disseminated like other OS (i.e. by a producer of OS as statistical product/release)

What could OS add (ctd.)?

- For their next revisions, classifications used in OS have to be assessed not only against demands in economic and social statistics, but also against environmental purposes
- In order to allow integration of data for illuminating environmentally relevant questions, systematic geo-coding should become standard in OS, especially for exhaustive sources (censuses and administrative sources)
- Surveys (especially business surveys) of OS have to be adapted/created to obtain empirical evidence for changes of key conversion factors over time. Key conversion factors may differ between countries

What could OS add? (ctd.)

- Use accounting frameworks (in physical, and where appropriate, in monetary units) for presenting statistics and indicators from different sources and about different phenomena as part of official statistics

- Supplement the flow based accounting frameworks by indicators measuring the capital (environmental, economic, human/social)

- Use the quality framework of OS also in environment statistics, with adaptations when necessary (until now mainly used in the context of social and economic statistics)

International level of OS

- National OS can benefit from international cooperation towards establishing and adopting standards for the above mentioned issues → Develop SOS (Standards of Official Statistics)

- UNCEEA work crucial

- ECE/OECD/EUROSTAT work on capital-based indicators of sustainability

Institutional issues

- Environment statistics should be officially recognised as key element of official statistics at national and international level, and be treated accordingly

- In view of the need for integrating many data sources and the many linkages to economic and social statistics, NSOs have to take the lead role in this area

- This does not imply that all data collection have to be with NSOs; like for administrative data sources, the primary data collection for many types of environmental data will remain completely outside the framework of official statistics

Institutional issues (ctd.)

- From the fundamental principles point of view, it is important to institutionally separate the production and dissemination of official statistics from advocacy functions (impartiality)

- Work on scenarios should take place under a joint institutional framework of OS agencies, researchers, and users

Limits of OS framework

- Limited to measure the now and the past

- Unit level data have to be kept confidential (but this does not mean that they cannot be used for ICPP purposes)

- Unit level data have to be grossed up from samples or partial observation to a target propulation, target geographical area (at least the national territory) and in most cases target period

- All results have to be disseminated simultaneously to all users

Limits of OS framework (ctd.)

- Methodologies have to be made transparent and accessible to public scrutiny

- Expert opinions cannot replace empirical evidence (excludes also e.g. subjective weighting for composite indicators)

- Conversion to monetary units is constrained by the availability of observable transaction prices (4th level of SEEA is outside OS)

Summary

- In the context of climate change, triple function for OS in the future:
  - Continue and improve its present function of statistical services
  - Develop, adopt and implement standards of OS for key components of environment statistics, and adapt standards in other areas so as to make them more relevant for use in the context of environment and climate change **(new function)**
  - Join forces with research community and users for analytical work such as scenarios and impact studies that are outside the framework of OS

THANK YOU!

Conference on Climate Change and Official Statistics

INEGI

Dr. Gilberto Calvillo Vives

Spatial Data Infrastructures and Climate Change Management

Oslo, Norway 14-16 april 2008

Contents

- UN Framework
- National strategy for climate change
- Climate change: A systemic approach
- Spatial data infrastructures
- Some indicators
- Mitigation and adaptation actions
- Present and future actions

UN Framework

Overview of United Nations activities in relation to climate change

Report of the Secretary-General

- An inclusive and coherent approach to climate change would enable the United Nations system to provide support for the negotiations on an international agreement on an effective post-2012 climate change framework, and provide a multisectorial mechanism through which to deliver on future agreements, as well as improve implementation of existing mandates.
- The United Nations needs to be more than merely the sum of its parts. To provide a solid platform and deliver a sound framework, concrete and meaningful cooperation across the United Nations system should be enhanced.

Overview of United Nations activities in relation to climate change

Report of the Secretary-General

IPCC	UNEP	WMO	UNESCO	UNDP
SBSTA	ICSU	JCOMM	IOC	FAO
EMG	UN-ENERGY	GTOS	GOOS	WFP
EGTT	UN-OCEANS	EMPRES	GCOS	UNICEF
EGIT	IAEA	CLIPS	RCOF	ILO
ITU	UNDG	IFAD	UN-WATER	WHO

ETC...

Overview of United Nations activities in relation to climate change

Report of the Secretary-General

WORD	APPEARS	WORD	APPEARS
CLIMATE	300 TIMES APROX.	UNSD	0 TIMES
STATISTICS	0 TIMES	PSR MODEL	
STATISTICAL	0 TIMES	GEOGRAPHY	0 TIMES
UNSC	0 TIMES	CARTO GRAPHY	

Overview of United Nations activities in relation to climate change

Report of the Secretary-General

- Actions to be coordinated:
  - Adaptation
  - Mitigation
  - Technology
  - Financing

National Strategy for Climate Change

National Strategy for Climate Change

INEGI

INTERSECRETARIAL COMISSION ON CLIMATE CHANGE

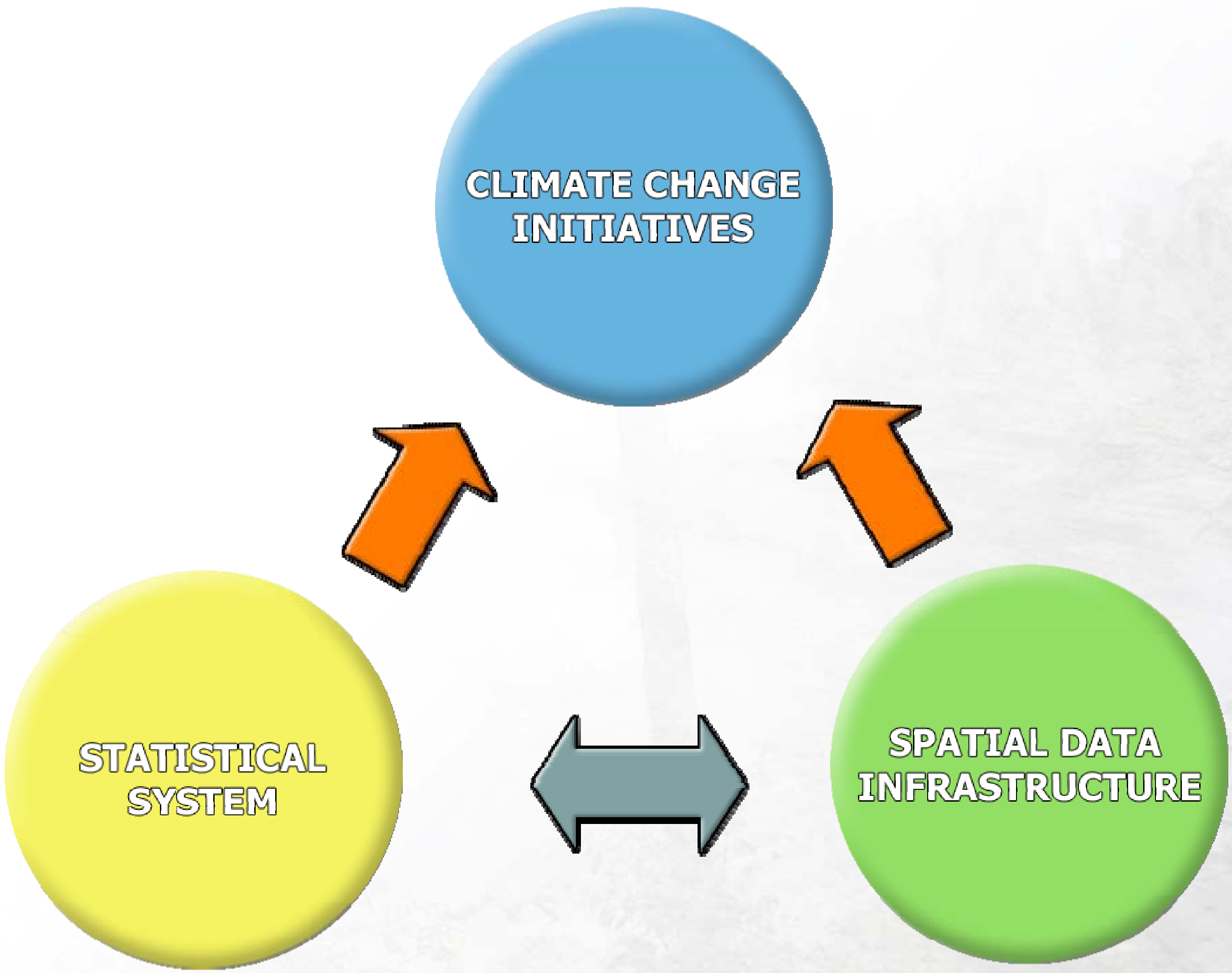
SAGARPA Agriculture	**SRE** Foreign Affairs
SEDESOL Social Development	**SCT** Communications and Transportation
SEMARNAT Environment	**SE** Economy
SHCP Finance (invited)	**SENER** Energy

National Strategy for Climate Change

Intersecretarial Commission on Climate Change

- Mexico´s strategy is based in two sets of actions for:
  - Adaptation
  - Mitigation
- They are in line with the Stern Review.

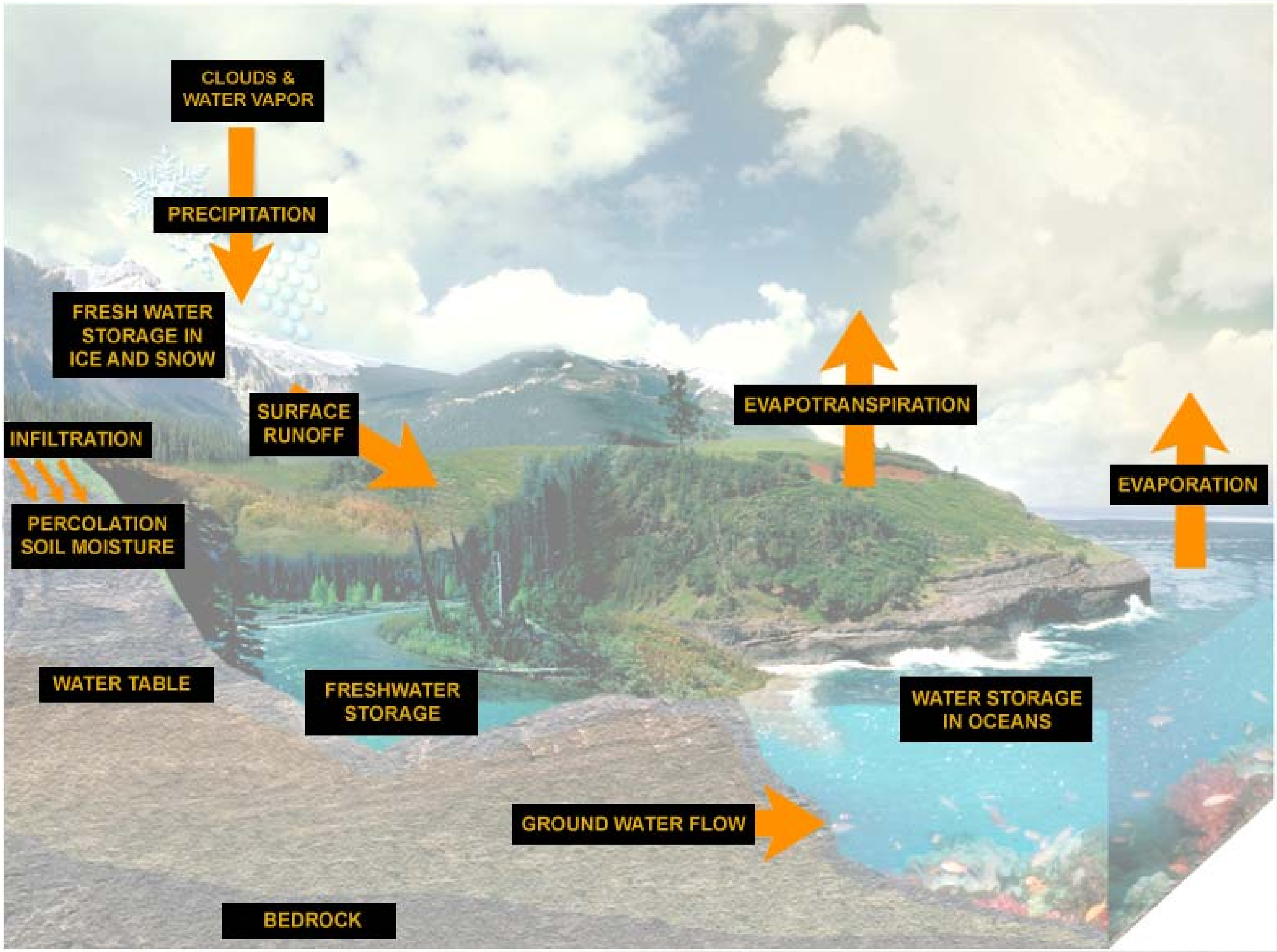
Challenge


CLIMATE CHANGE INITIATIVES
STATISTICAL SYSTEM
SPATIAL DATA INFRASTRUCTURE

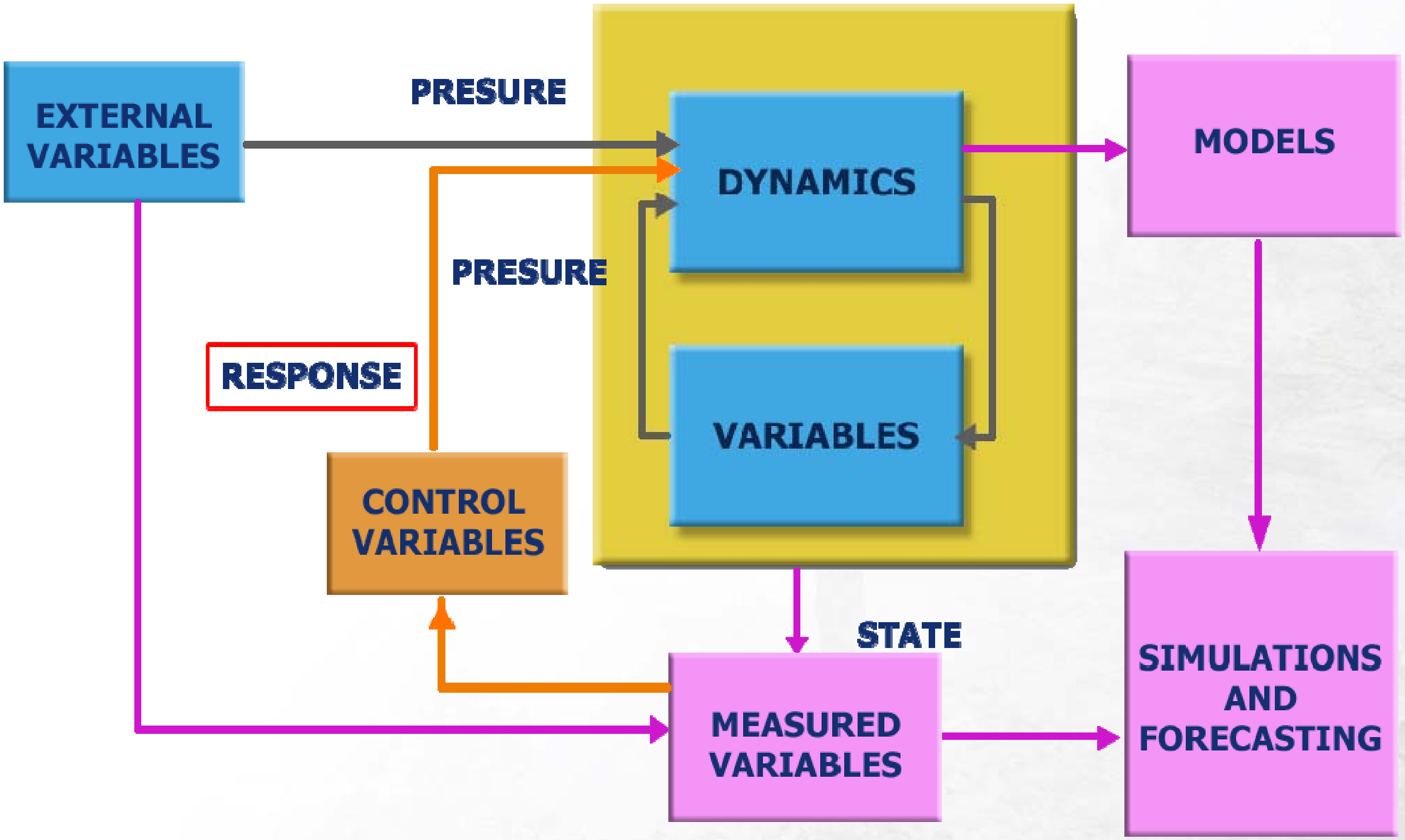
Climate Change:
A Systemic Approach

System Earth

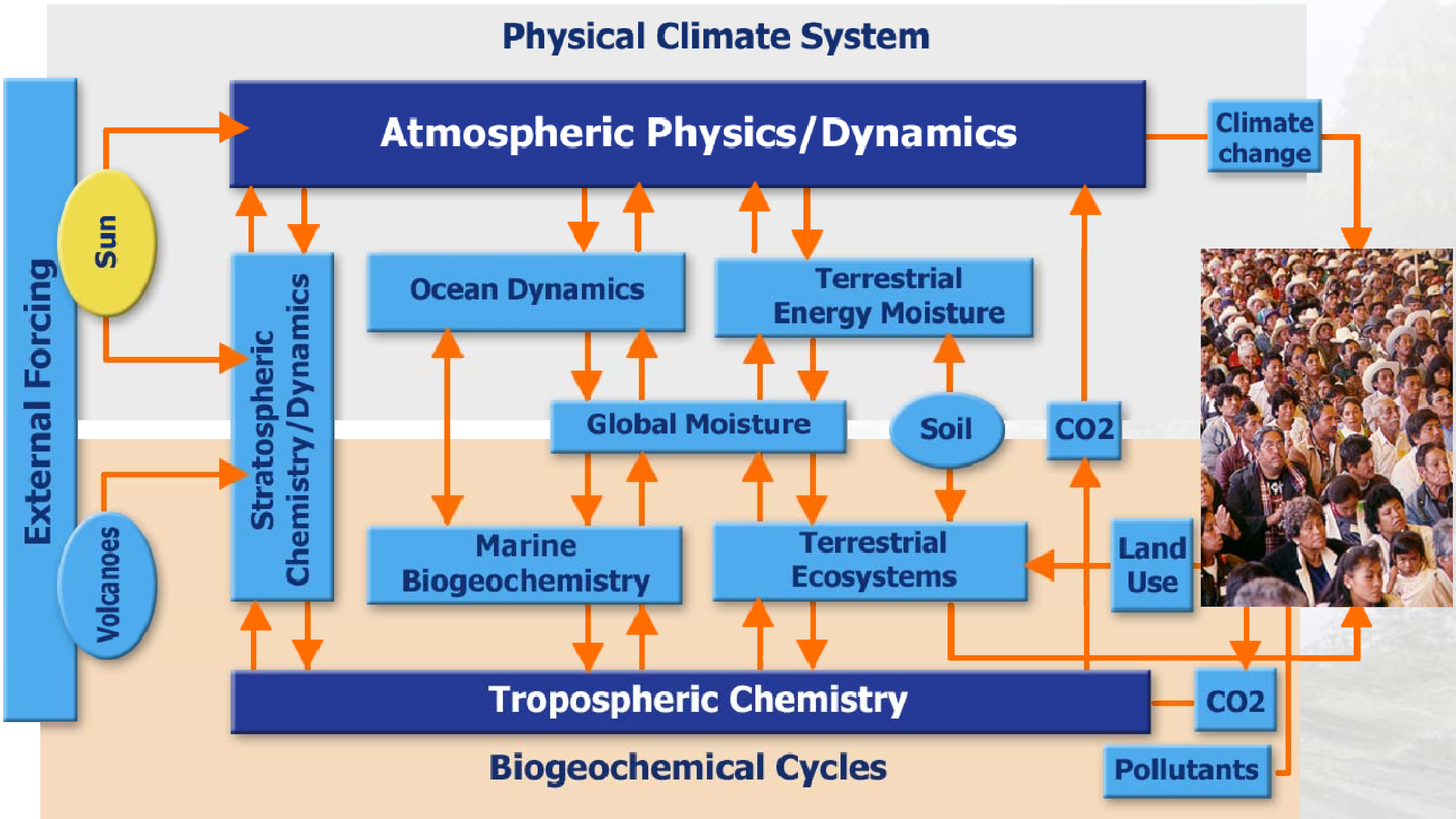
- Water cycle



System Earth



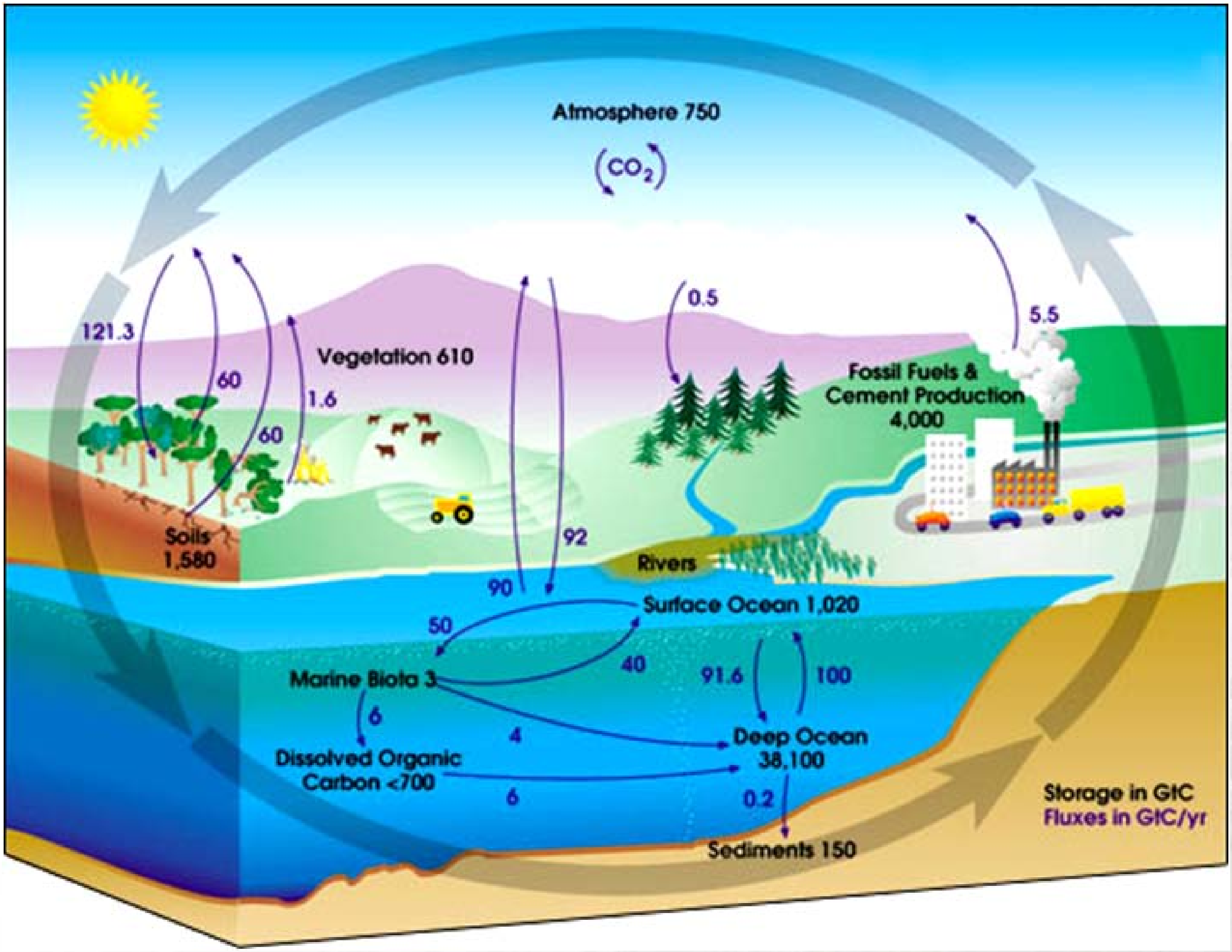
Climate Change System



(from Earth System Science-Overview, NASA, 1986)

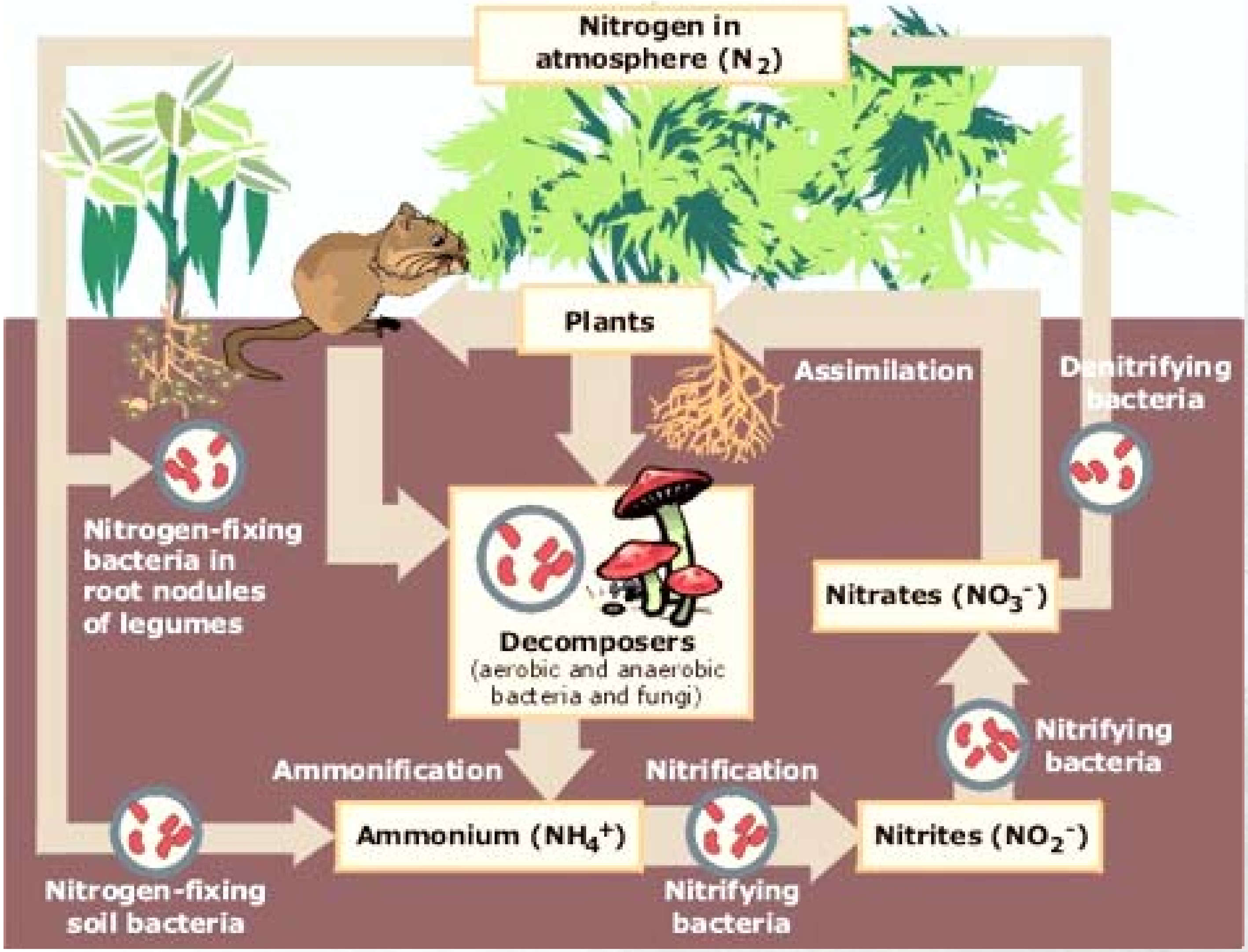
Models

- Carbon cycle



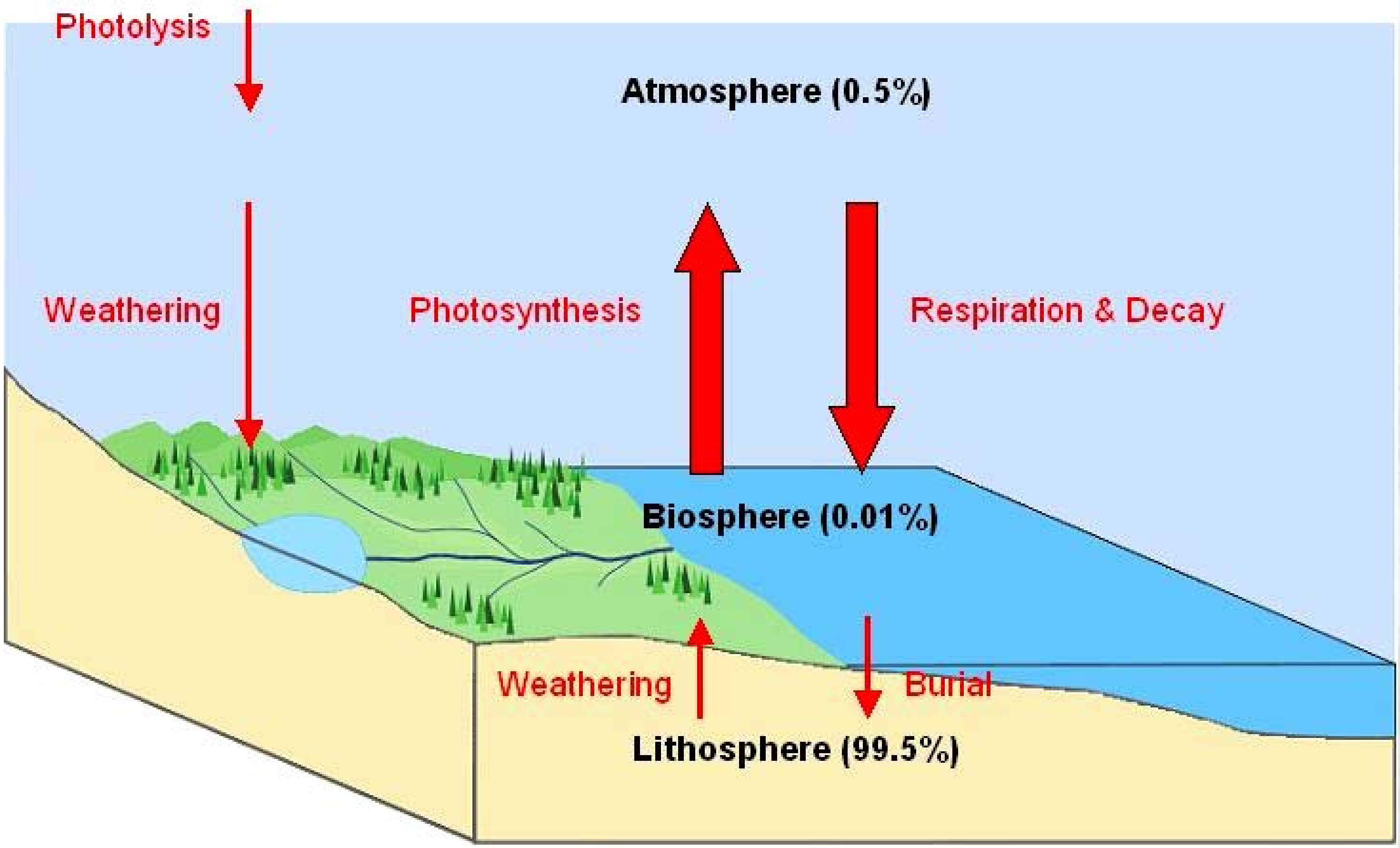
Models

- Nitrogen cycle



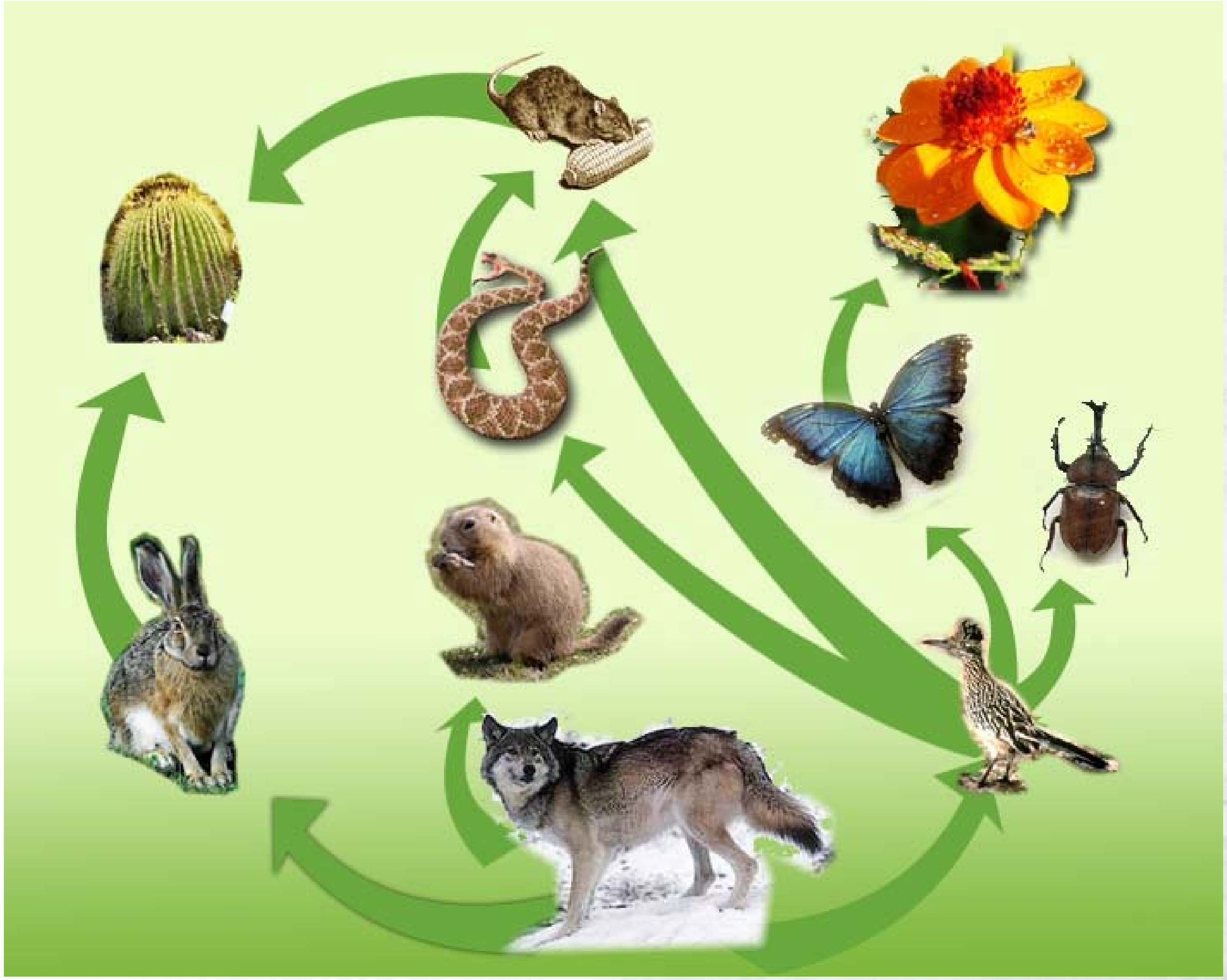
Models

- Oxygen cycle



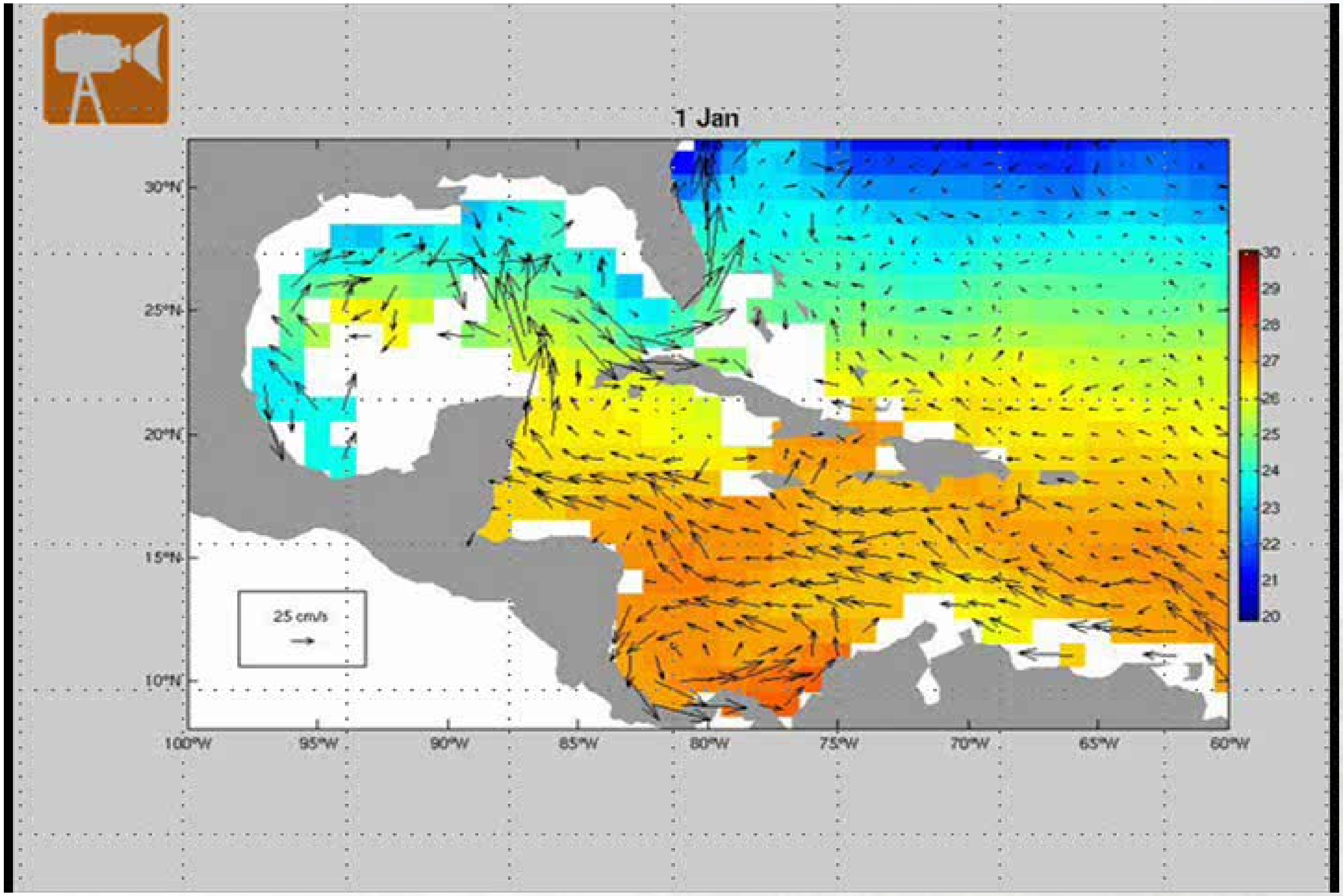
Models

- Ecosystem



Models

- Ocean currents distribute heat around the world.

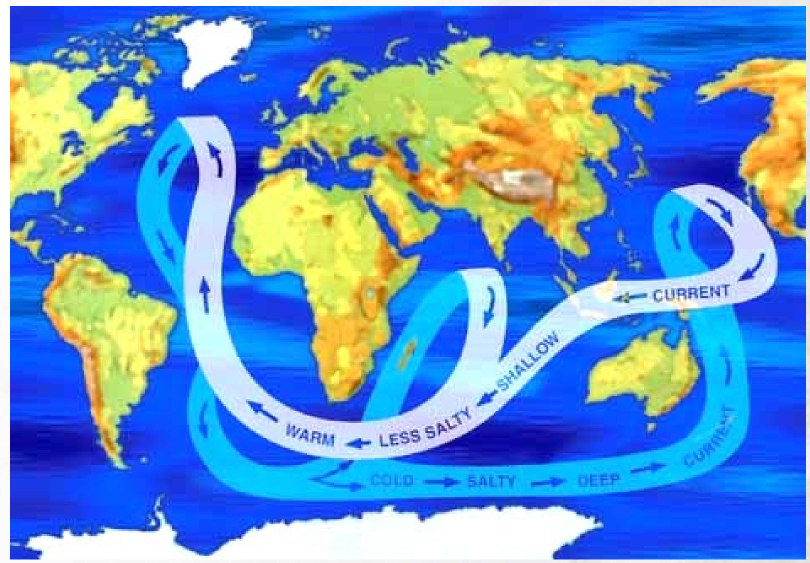


Models

Mathematical models that allow simulation of diverse processes in all spheres have been in a constant improvement during the last 50 years.

It´s important to keep in mind that we are dealing with a very complex system, where the most interesting feature is the nonlinearity of their dynamics and the way they confirm that in the case of climate change everything is related to everything else.

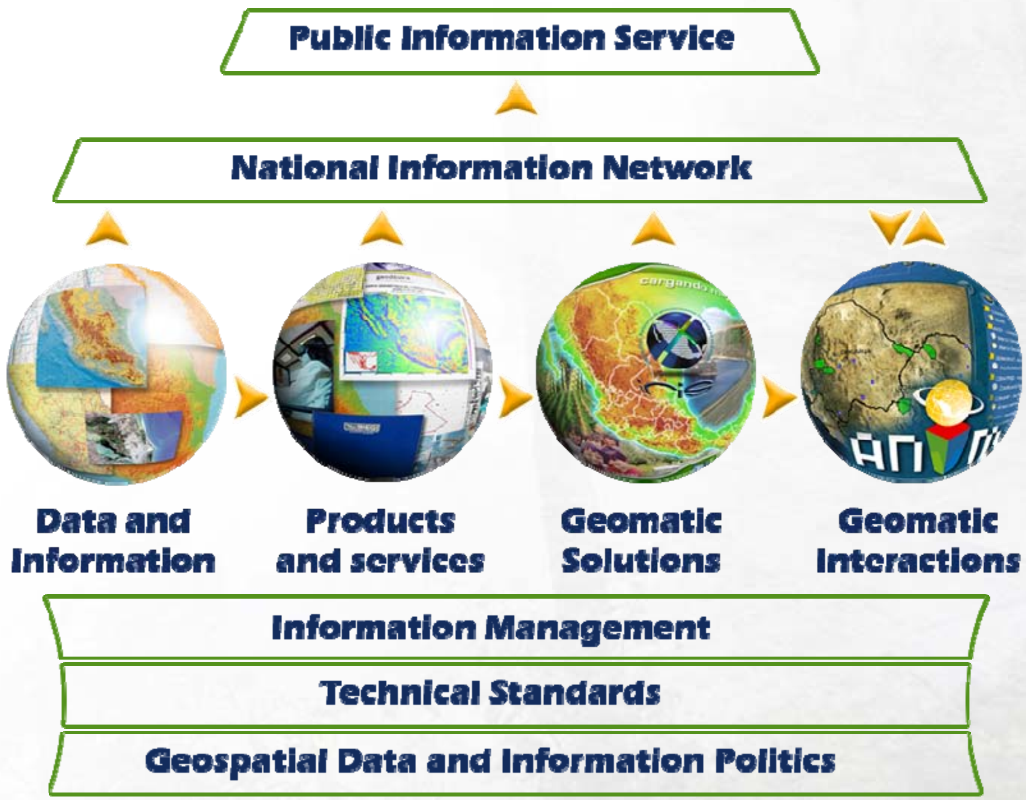
In order to improve our knowledge, better models are required which need more and better information.



Spatial Data Infrastructures

Spatial Data Infrastructures

A Spatial Data Infrastructure (SDI) is a systemic approach to coordinate the parties involved in the development and use of spatial data of a region. It includes policies, standards, technologies, and human resources that are necessary for efficient compilation, access, distribution and exploitation of geographical information.



Spatial Data Infrastructures

Countries that count with a Spatial Data Infrastructure iniciative documented or with a web page.

América

1. Argentina
2. Belice
3. Bolivia
4. Brasil
5. Canadá
6. Chile
7. Colombia
8. Costa Rica
9. Cuba
10. Ecuador
11. El Salvador
12. Estados Unidos
13. Guatemala
14. Guyana
15. Honduras
16. Jamaica
17. México
18. Nicaragua
19. Panamá
20. Paraguay
21. Perú
22. República Dominicana
23. Uruguay
24. Venezuela

Africa

25. Kenia
26. Kiribati
27. Sudáfrica

Europa

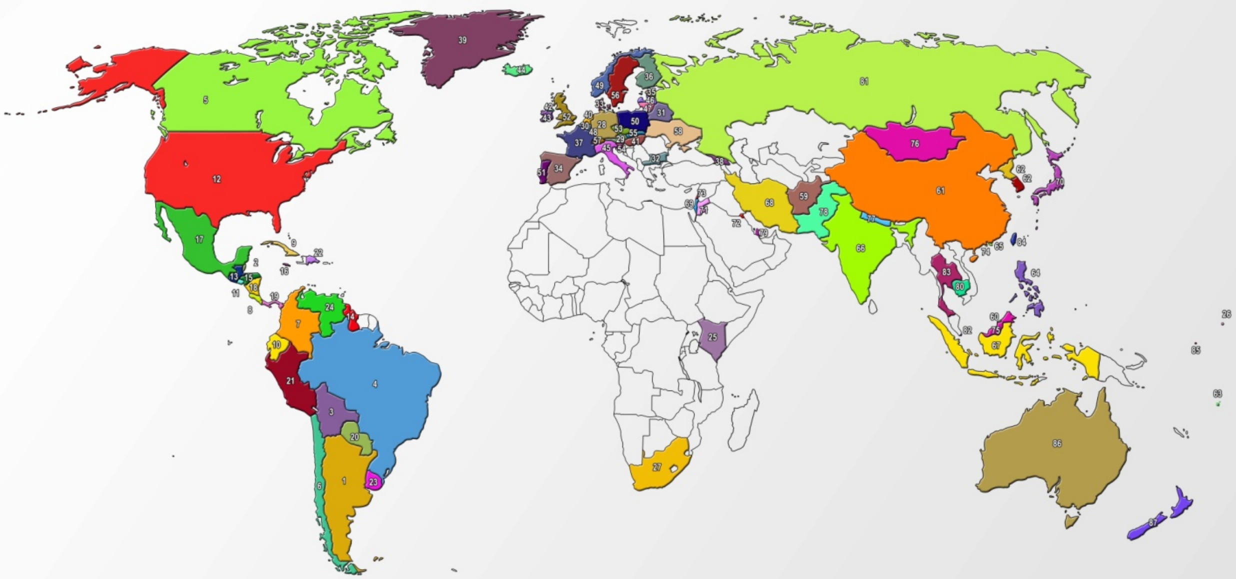
28. Alemania
29. Austria
30. Bélgica
31. Bielorusia
32. Bulgaria
33. Dinamarca
34. España
35. Estonia
36. Finlandia
37. Francia
38. Georgia
39. Groenlandia
40. Holanda
41. Hungría
42. Irlanda
43. Irlanda del Norte
44. Islandia
45. Italia
46. Letonia
47. Lituania
48. Luxemburgo
49. Noruega
50. Polonia
51. Portugal
52. Reino Unido
53. República Checa
54. República de Eslovenia
55. República Eslovaca
56. Suecia
57. Suiza
58. Ucrania

Asia

59. Afganistan
60. Brunei Darussalam
61. China
62. Corea
63. Fiji
64. Filipinas
65. Hong Kong
66. India
67. Indonesia
68. Irán
69. Israel
70. Japón
71. Jordania
72. Kuwait
73. Líbano
74. Macau
75. Malasia
76. Mongolia
77. Nepal
78. Pakistán
79. Qatar
80. Reinio de Cambodia
81. Rusia
82. Singapur
83. Tailandia
84. Taiwan
85. Tuvalu

Australia

86. Australia
87. Nueva Zelanda



Spatial Data Infrastructures

Global Spatial Data Infrastructure
www.gsdi.org/

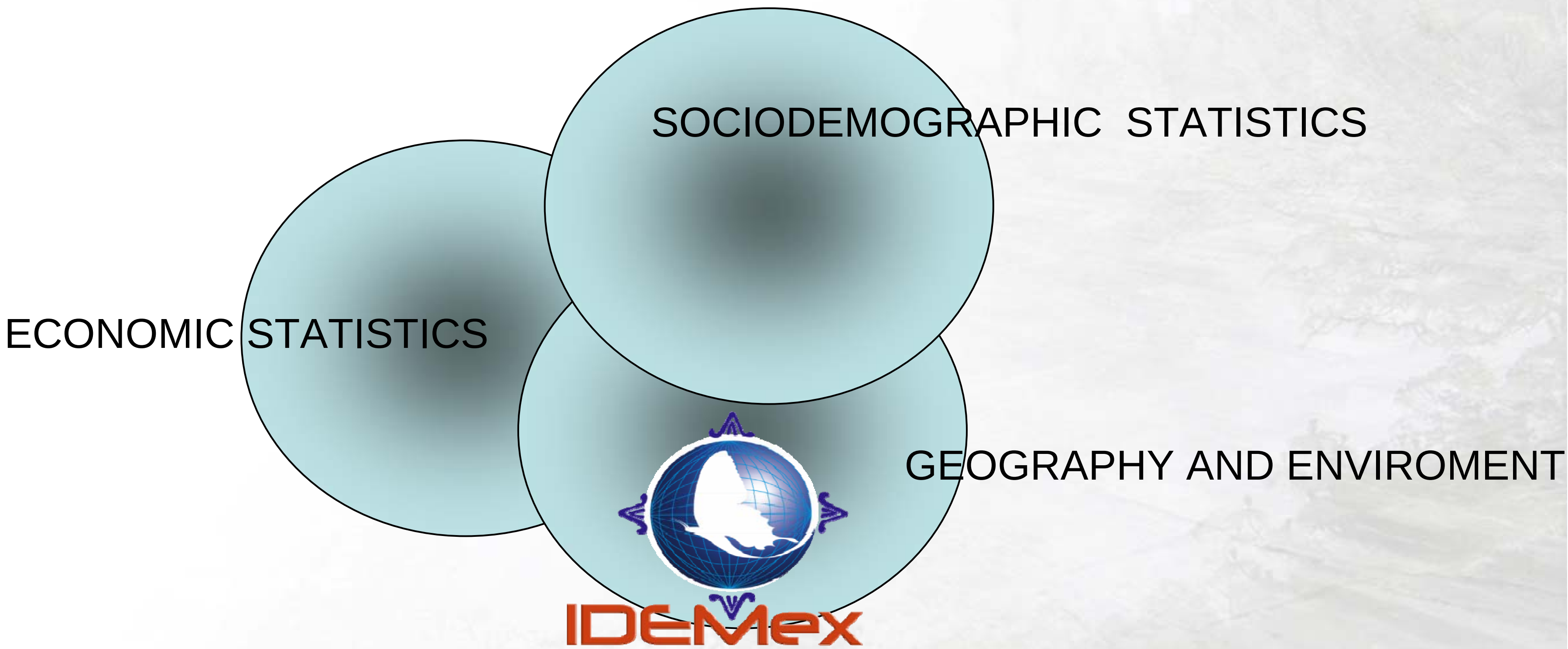
SDI of the Americas
www.cp-idea.org/nuevoSitio/indice.html

SDI of Mexico
www.inegi.gob.mx/geo/contenidos/espanol/IDEMex.pdf?s=geo&c=1352

SDI of the state of Michoacan

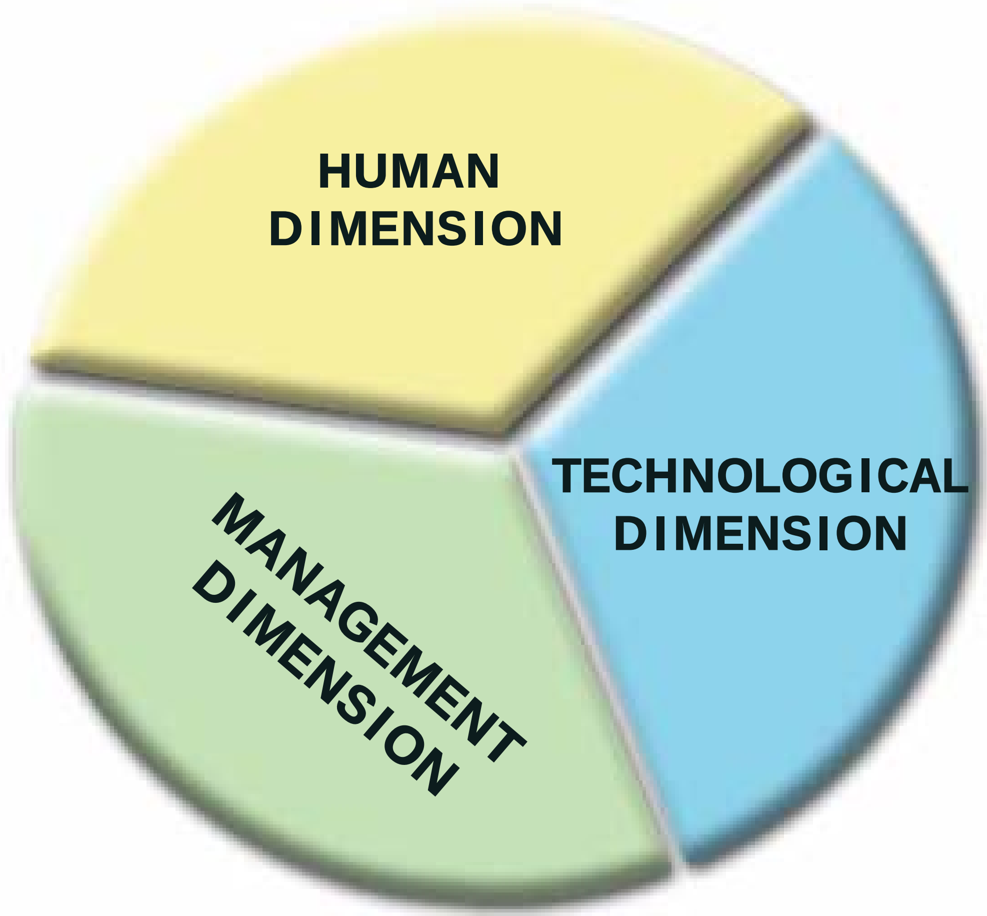
IDEMex, Mexico´s SDI

IDEMex is the geographical part of the geography and enviroment subsystem of the NATIONAL INFORMATION SYSTEM OF GEOGRAPHY AND STATISTICS.



IDEMex, Mexico´s SDI

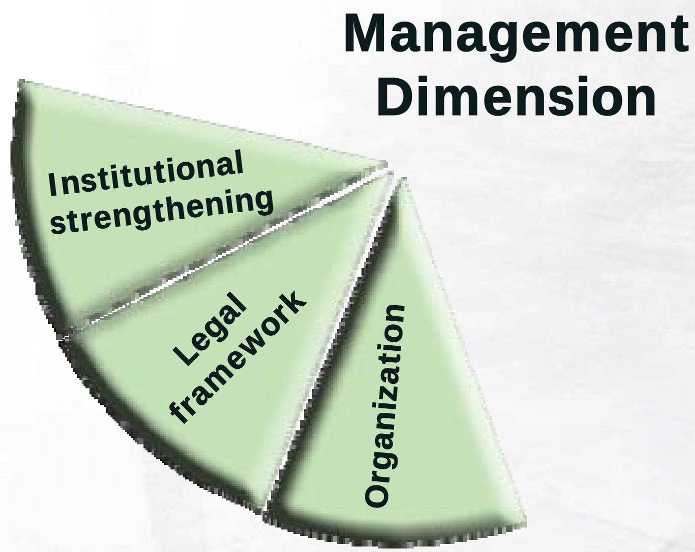
IDEMex is organized in three interconected areas or dimensions



IDEMex, Mexico´s SDI

54 Statistical and Geographical Technical Comitees:

- National: 2
- Sectorial: 18
- Regional: 32
- Special: 2



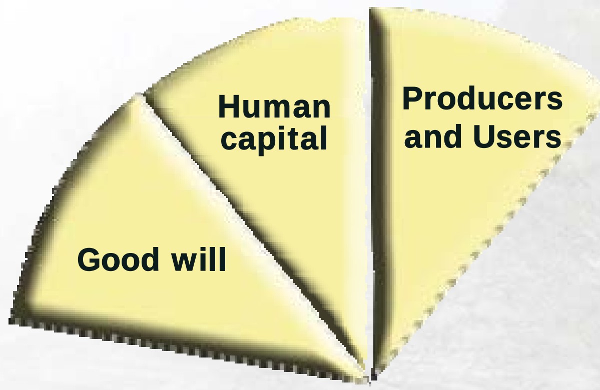
IDEMex, Mexico´s SDI

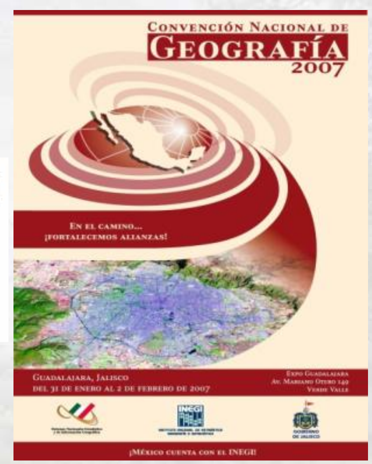
- INEGI
- SEMARNAT (Ministry of Environment)
  - CONANP (National Protected Areas Commission)
  - CONAGUA (National Water Commission)
  - CONAFOR (National Forest Commission)
  - IMTA (Mexican Water Technology Institute)
  - INE (National Ecology Institute)
  - PROFEPA (Environmental Protection Federal Office)
  - CONABIO (National Commission for Biodiversity)
- SGM (Mexican Geological Survey)
- SMN (Mexican Meteorological Survey)
- CENAPRED (National Center for Disaster Prevention)
- Etc.

IDEMex, the Mexican initiative

- Interinstitucional coordination
- National and International Forums
- Strategic alliances

Human Dimention

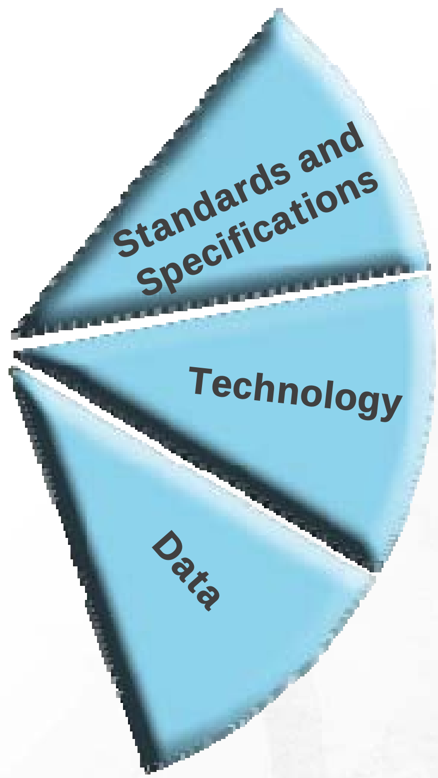




IDEMex, the Mexican initiative

Technical Dimention

- Standards
- Technology
- Data

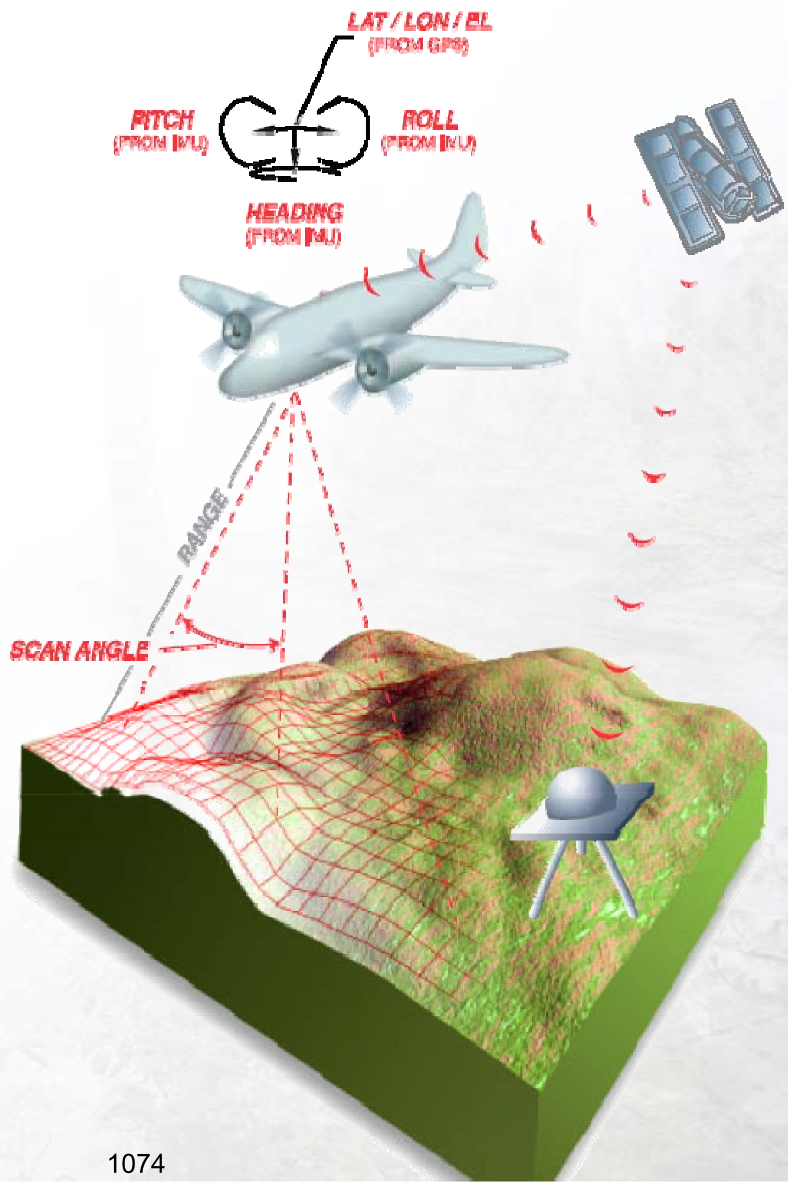


Navegante Geoestadístico de México





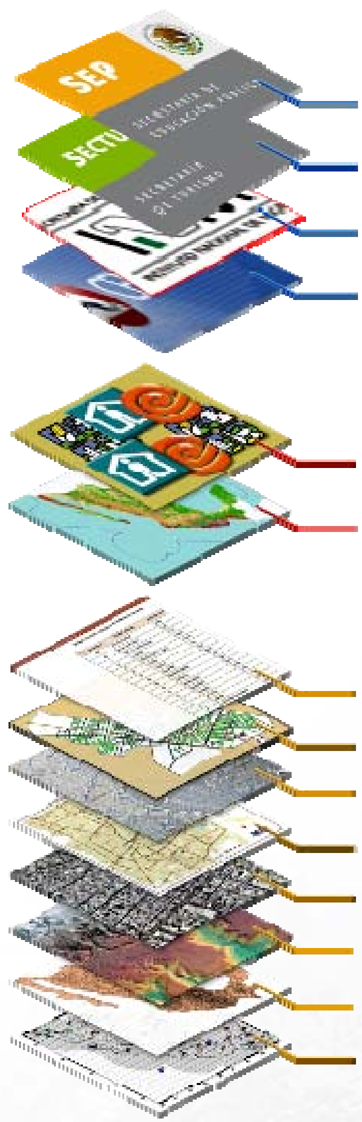
- LIDAR technology




FUJIFILM
Leica

IDEMex, the Mexican initiative

Spatial Data Classification



Added value

Education,
Tourism,
Mining, Forests, Soils,
Water, Weather, Migration,
Ecology, Disasters,
Waste disposal, Health, Economy,
etc.

Basics

Geostatistical data (Sociodemographic and Economic statitics)

Natural resources (Geology, Soils, Hydrology, Land Use and Vegetation, Physiography, Climatology, Bathymetry, ...)

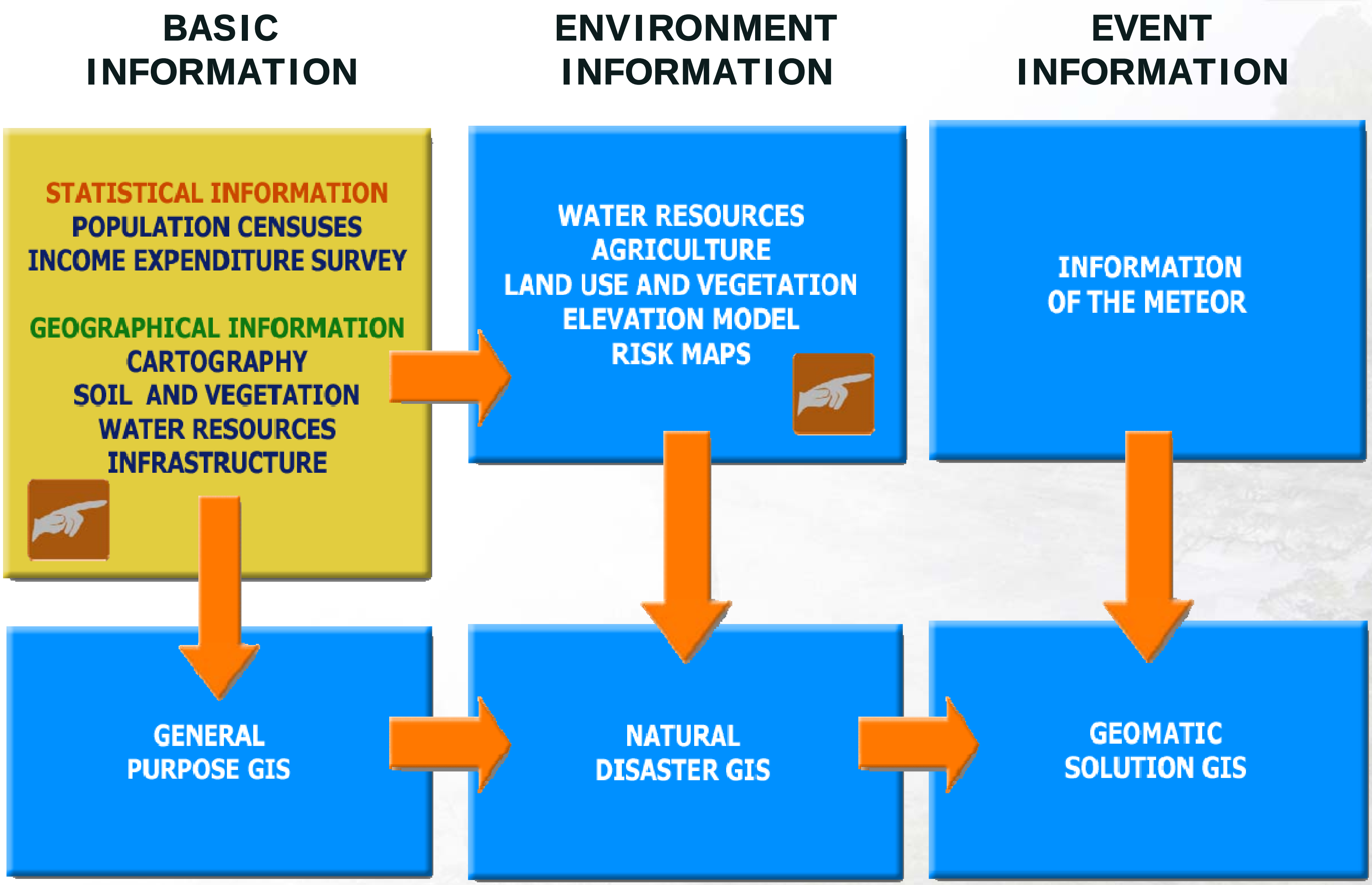
Fundamentals

Geographic names
Cadastral data
Hydrographic networks
Transportation routes and Planimetric data
Imagery
Relief data
International, state and intrastate boundaries, geostatistical, etc
Geodetic references

IDEMex, the Mexican initiative

Demographic, social, economic and cartographic information is integrated in Geographical Information Systems.

Censuses


BASIC INFORMATION
ENVIRONMENT INFORMATION
EVENT INFORMATION
STATISTICAL INFORMATION
POPULATION CENSUSES
INCOME EXPENDITURE SURVEY
GEOGRAPHICAL INFORMATION
CARTOGRAPHY
SOIL AND VEGETATION
WATER RESOURCES
INFRASTRUCTURE
WATER RESOURCES
AGRICULTURE
LAND USE AND VEGETATION
ELEVATION MODEL
RISK MAPS
INFORMATION OF THE METEOR
GENERAL PURPOSE GIS
NATURAL DISASTER GIS
GEOMATIC SOLUTION GIS

Water and Population

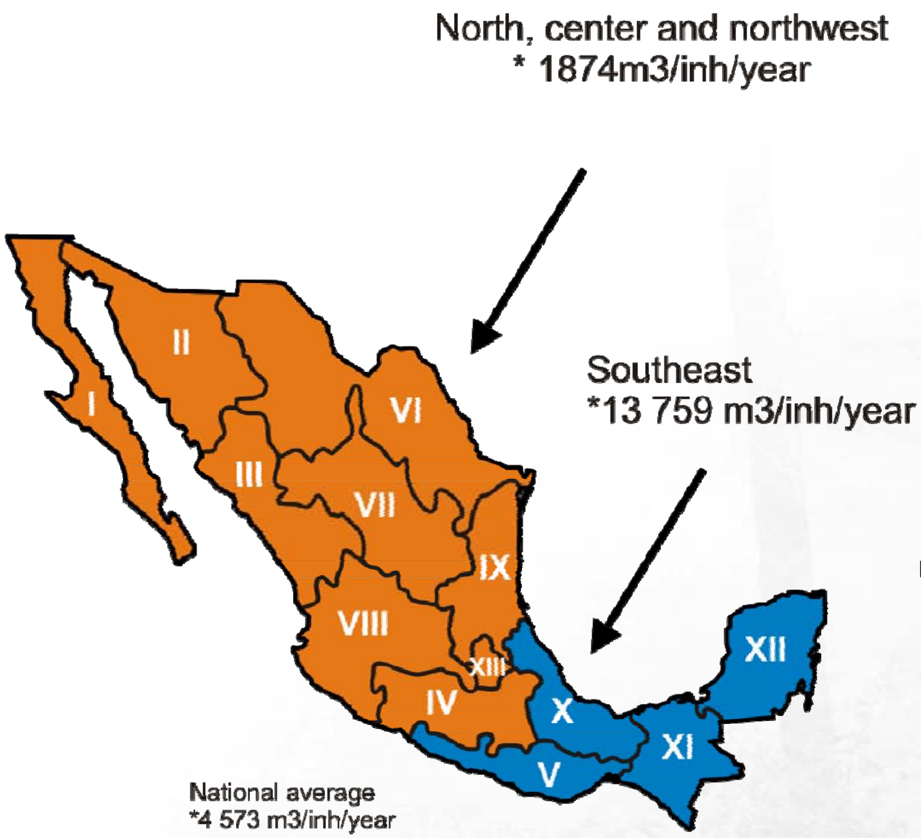
Water availability in Mexico is estimated in 500 billions of m^3

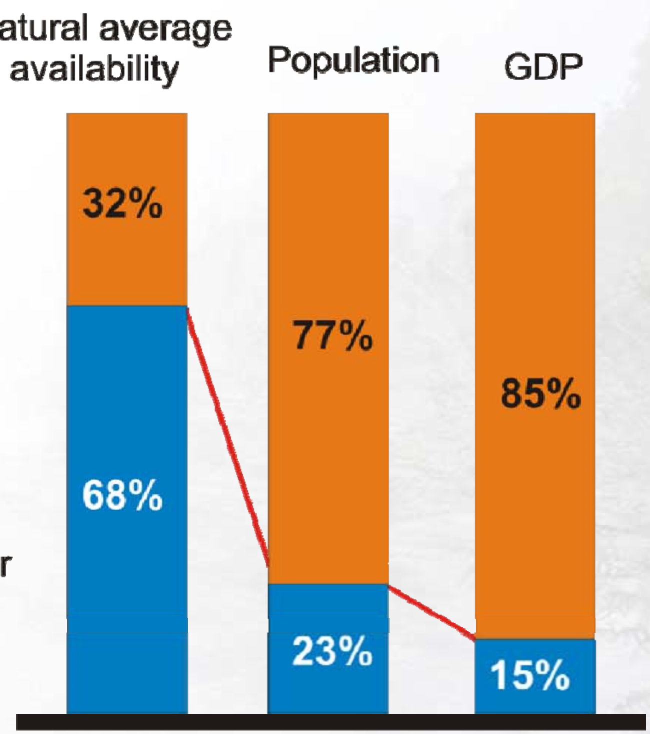
Mexico´s population is around 106 million.

One third of its population is settled higher than 2,000 masl, where just 4% of the annual runoff is generated.

In contrast, less than 25% of the population is in the southeast, where drains 67% of the total and concentrates 80% of the water storage capacity.

Water availability and development





*Source: Population and housing census; october 2005.

National average
*4 573 m3/inh/year

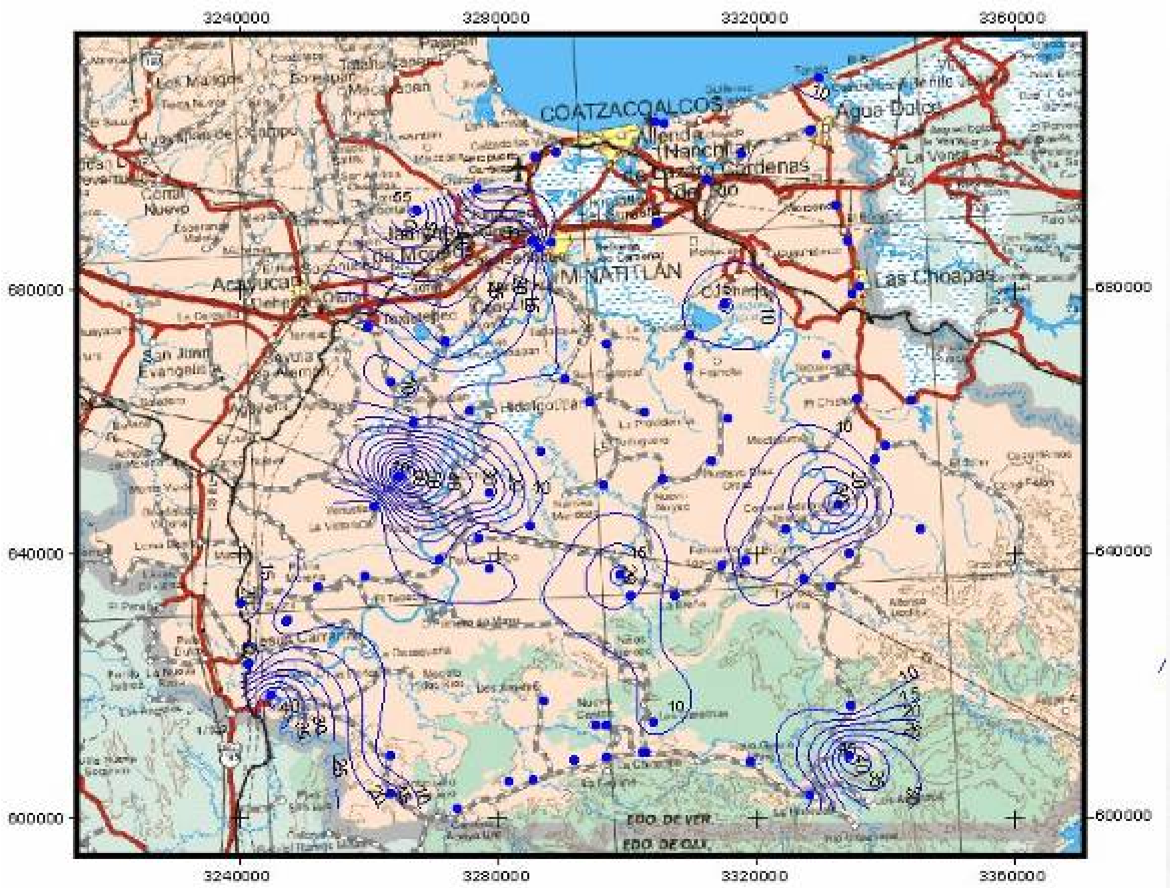
Source Information: National Water Comission. CANAGUA

Some Indicators

Nitrate content in water

Source – INEGI, Hydrological information, Multiple series

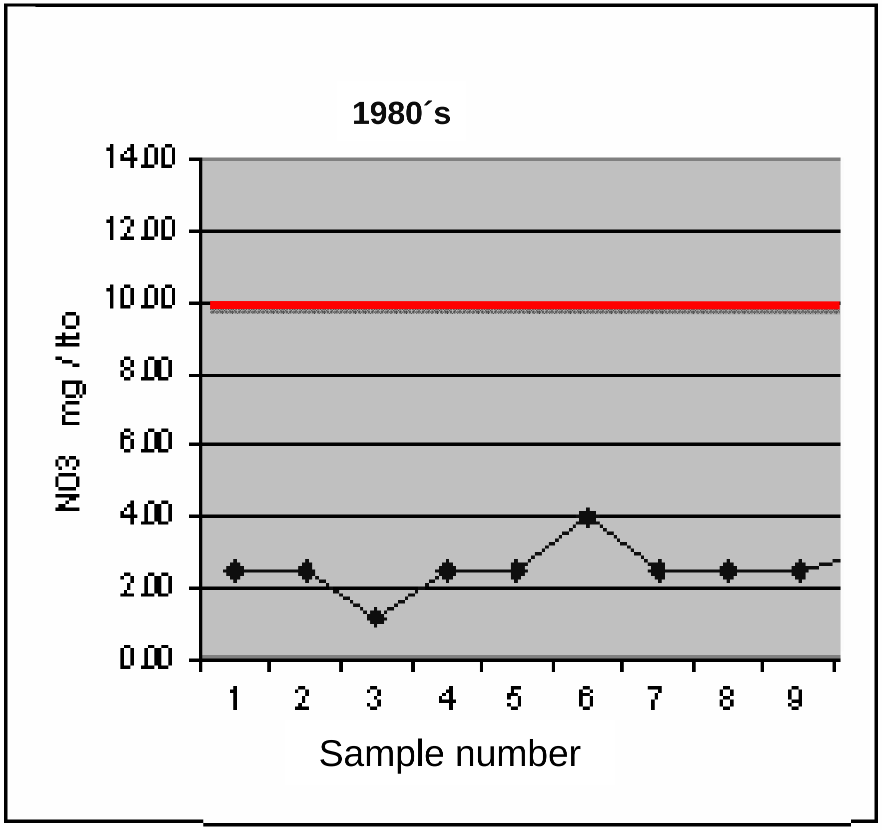
Spatial expression

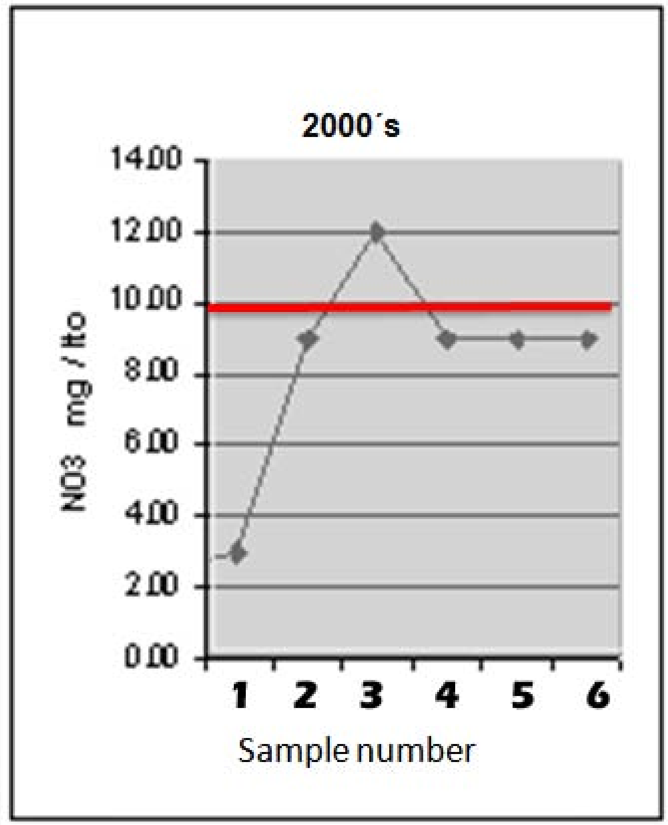


Nitrate is an indirect indicator of the presence of anthropic pollution.

The maximum permissible concentration is 10 mg/lt (NOM-127-SSA-1-1994)

Temporary expression

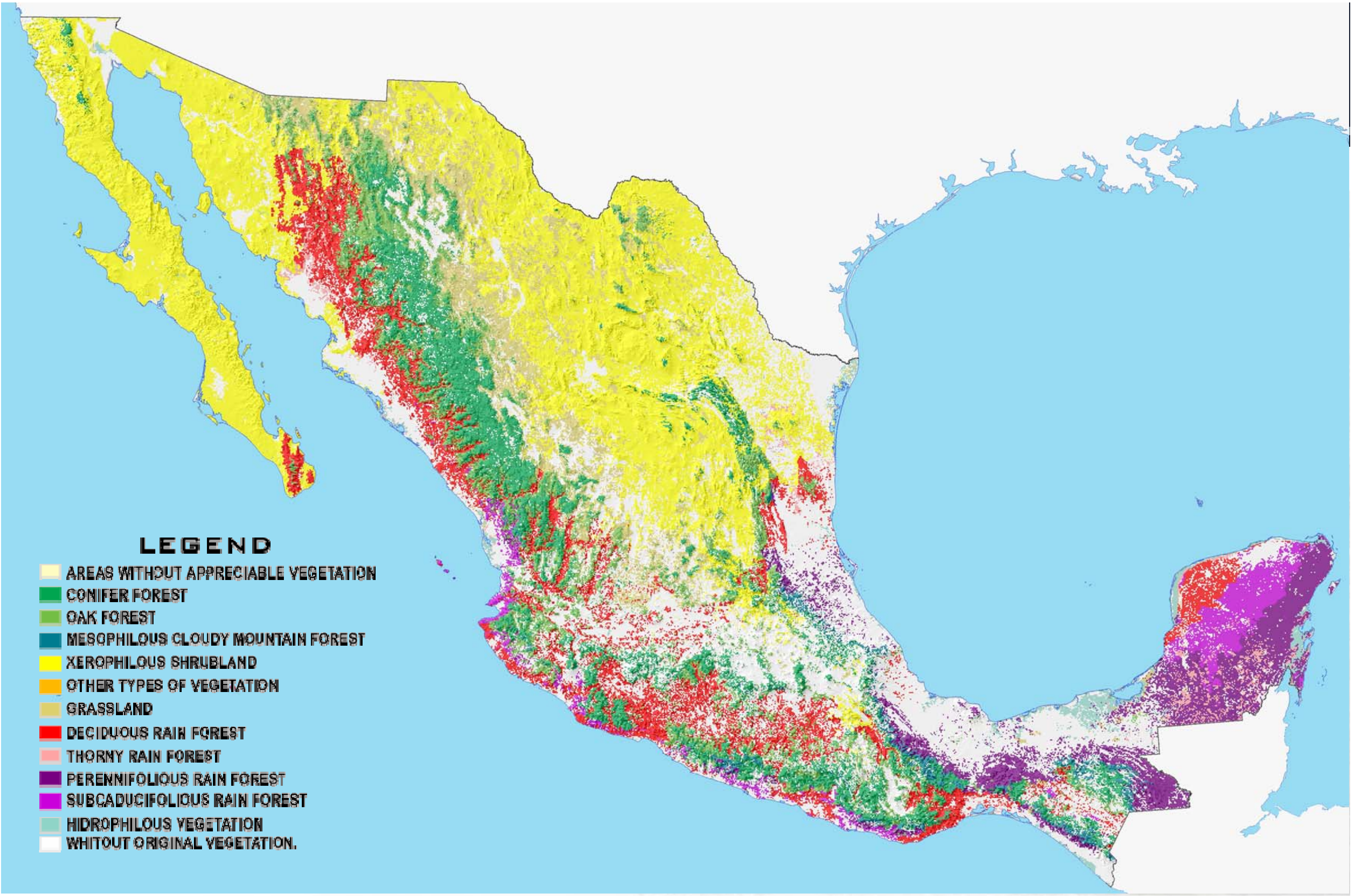




Nitrates concentration from water samples collected on Panuco´s river runof.

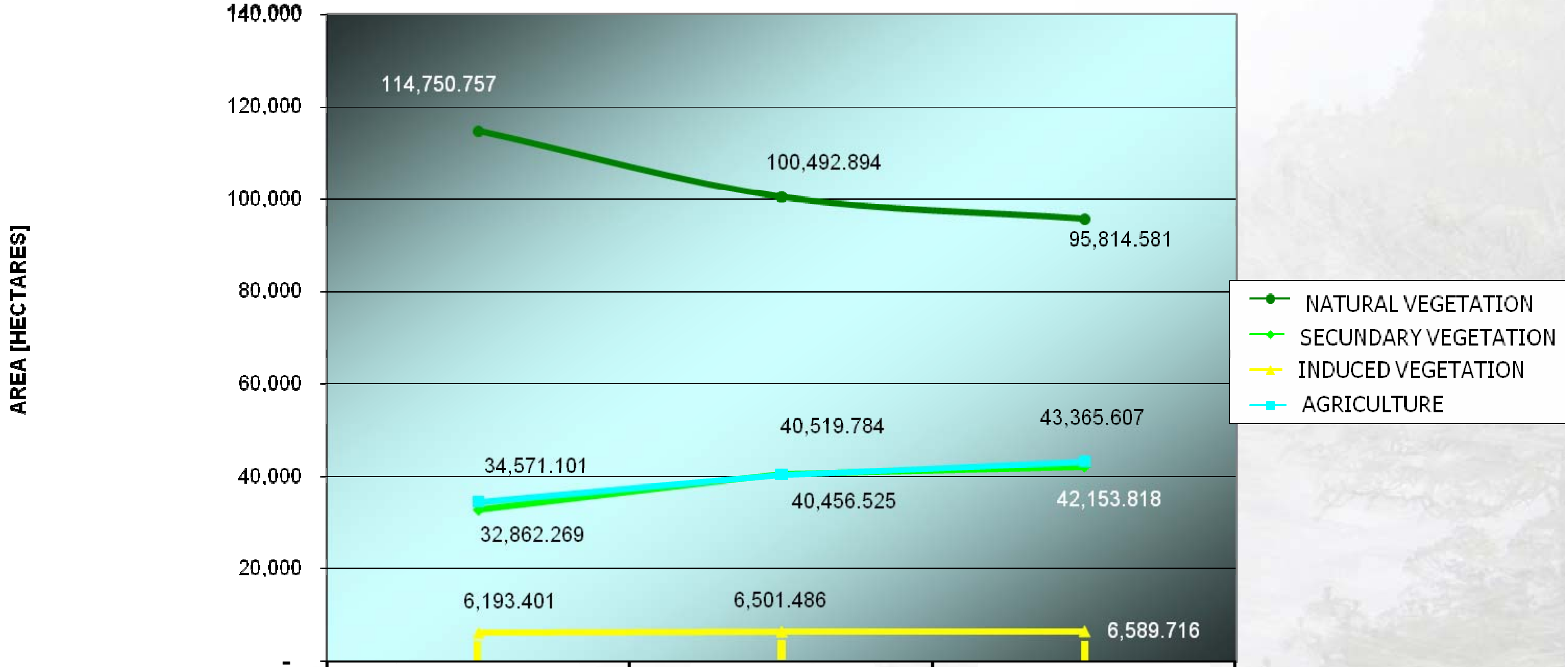
Change of the vegetal cover

Source – INEGI, Land use and vegetation information Multiple series

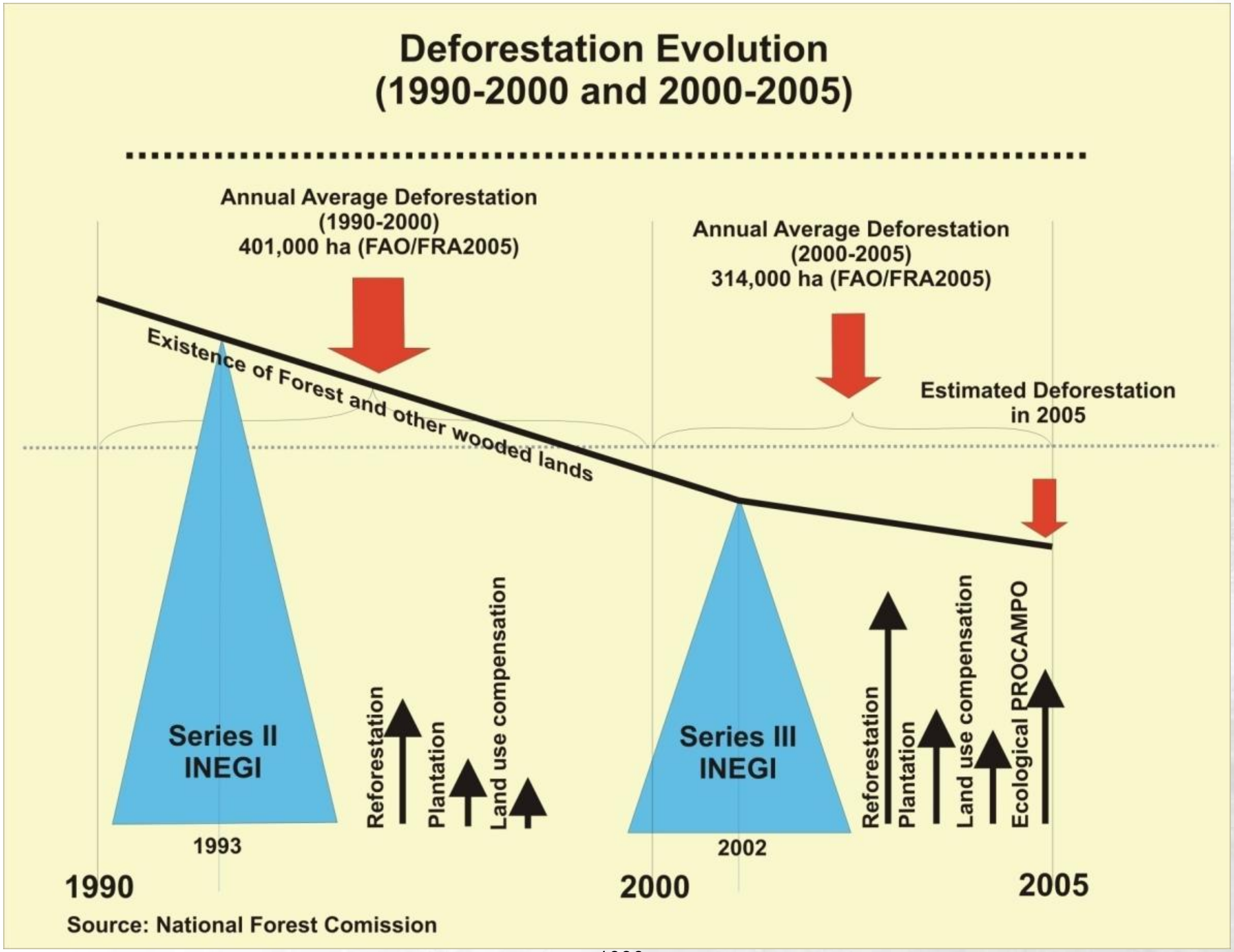


Vegetation map – 2000´s

Temporary expression

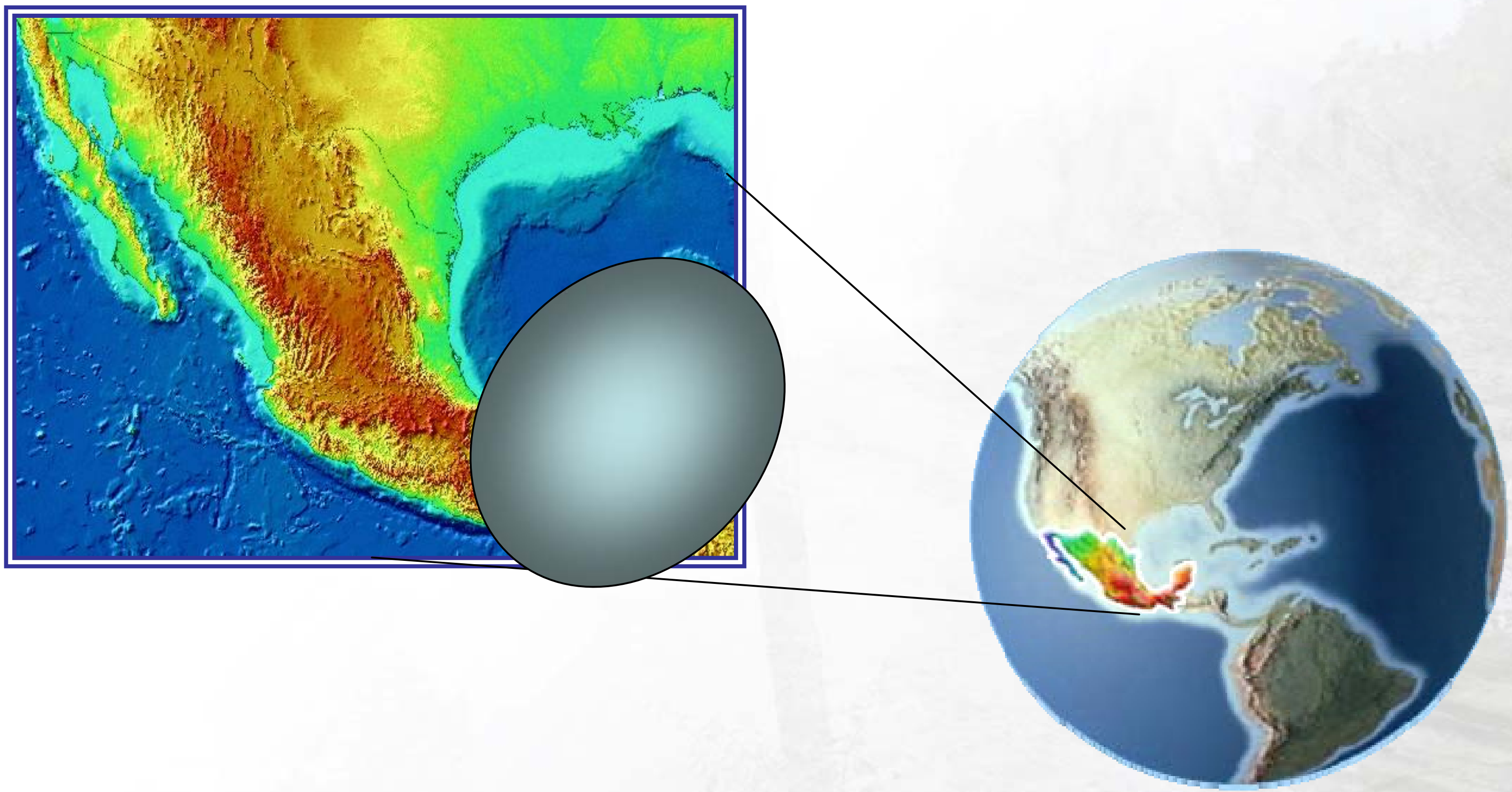


	SERIES I (80's)	SERIES II (90's)	SERIES III (2002-05)
NATURAL VEGETATION	114.750.756.572	100.492.894.320	95.814.581.428
SECUNDARY VEGETATION	32.862.269.283	40.456.525.324	42.153.817.938
INDUCED VEGETATION	6.193.400.820	6.501.485.954	6.589.715.800
AGRICULTURE	34.571.101.428	40.519.784.005	43.365.606.627


Deforestation Evolution
(1990-2000 and 2000-2005)
Annual Average Deforestation
(1990-2000)
401,000 ha (FAO/FRA2005)
Annual Average Deforestation
(2000-2005)
314,000 ha (FAO/FRA2005)
Estimated Deforestation
in 2005
Existence of Forest and other wooded lands
Series II
INEGI
1993
Reforestation
Plantation
Land use compensation
Series III
INEGI
2002
Reforestation
Plantation
Land use compensation
Ecological PROCAMPO
1990
2000
2005
Source: National Forest Comission

Mitigation and Adaptation Actions

Adaptation to
Hidrographyc Anomalies



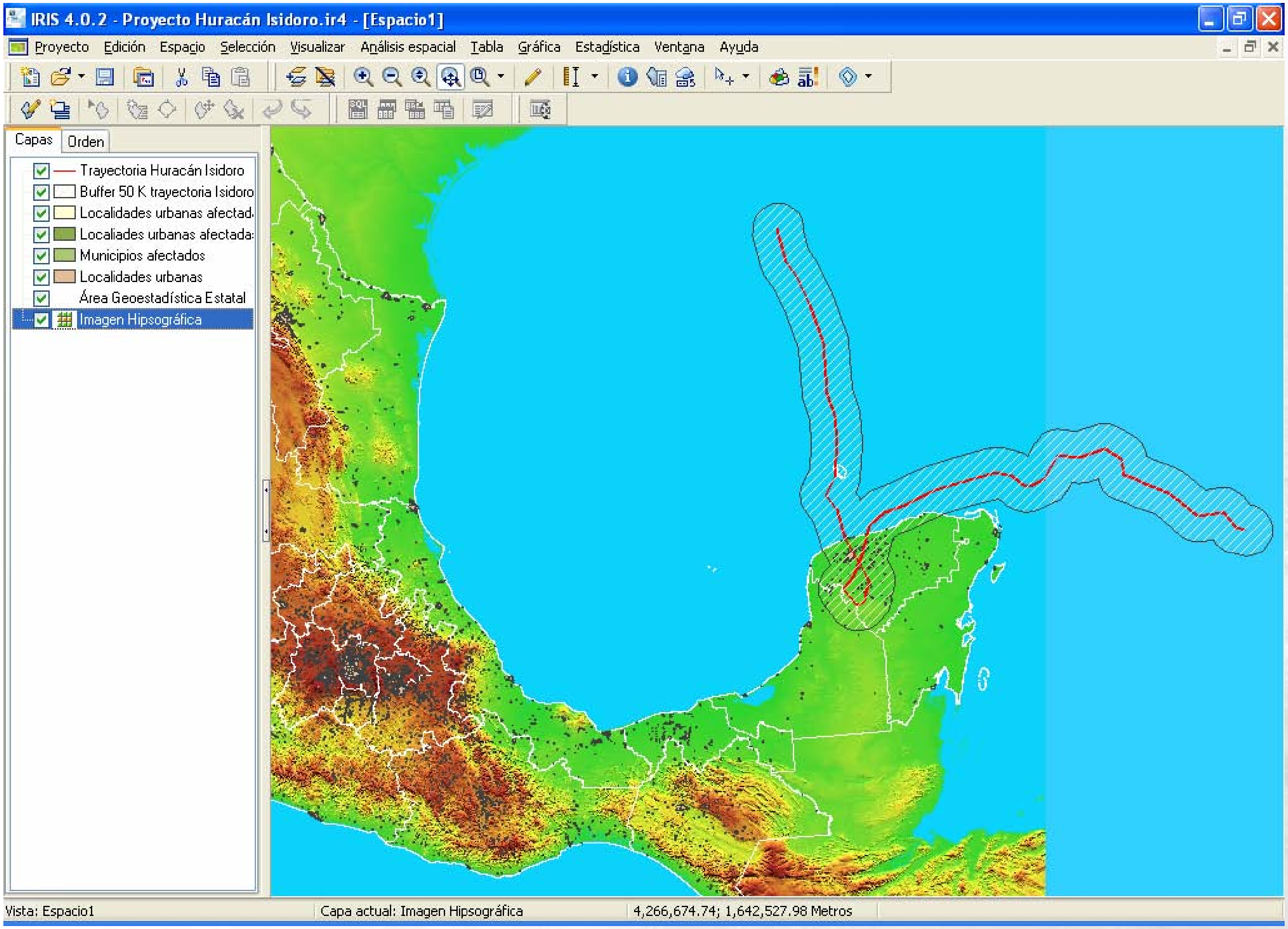
INEGI faces these events through GT-SIGER, that is a decision support working group.

In this cases, opportune geographic and statistical information are necessary for the detection, assessment and mitigation of disasters.

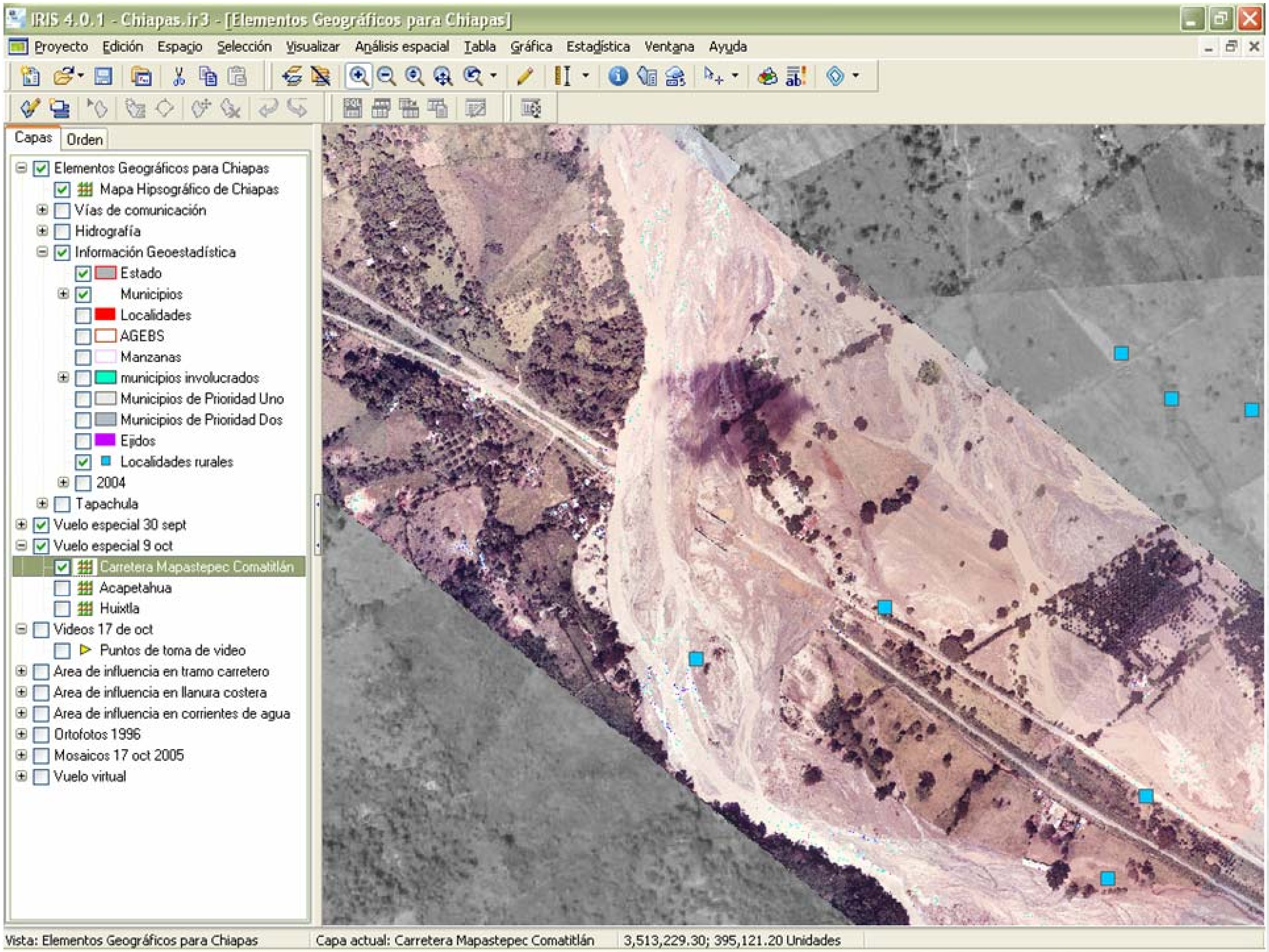
The following are the main activities that GT-SIGER leads:

- Special photographic and LIDAR flights
- Satellite imagery acquisition, processing and interpretation
- Statistical and geographical compilation
- Geographic Information System integration
- Web dissemination of the information

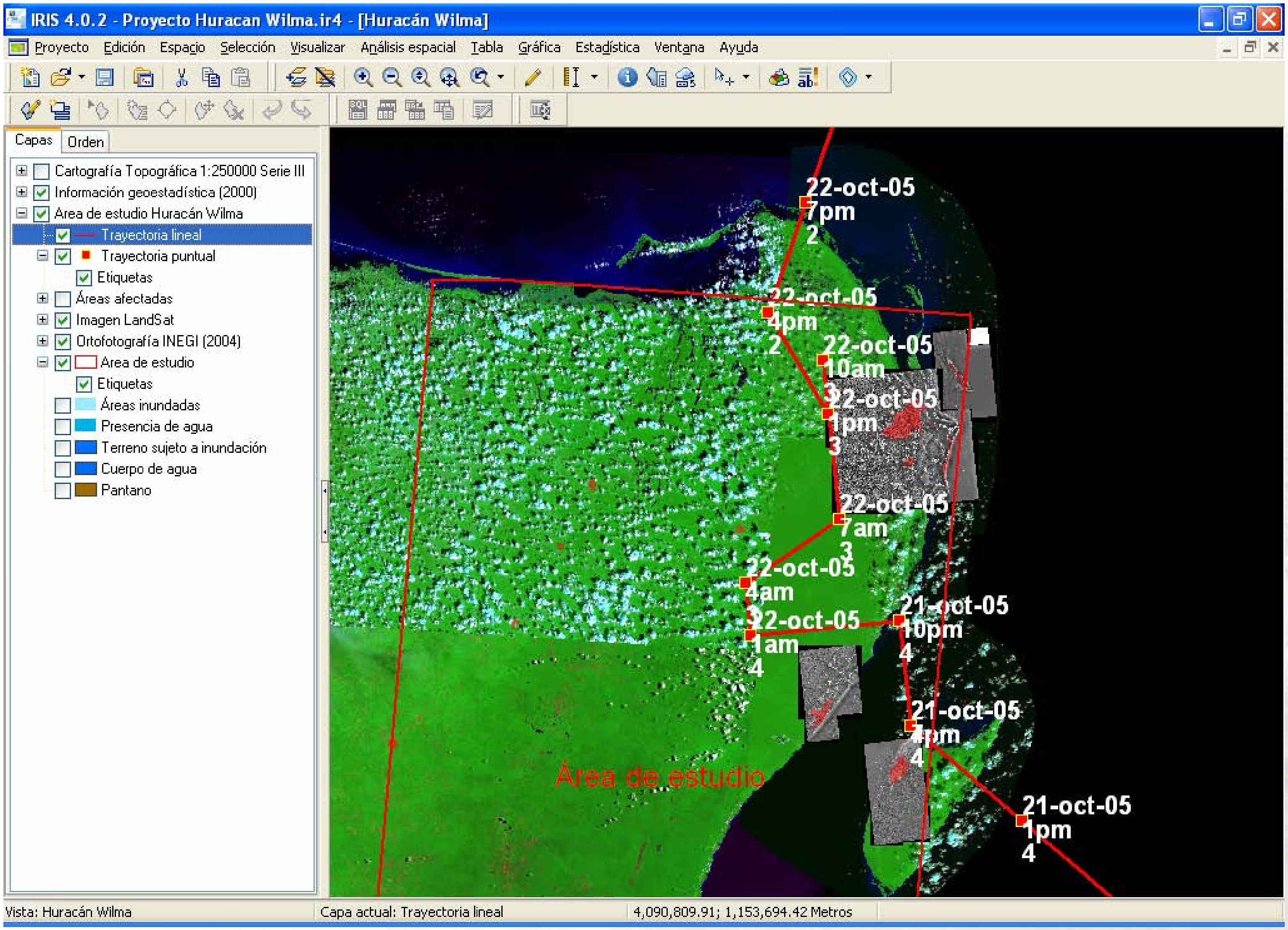
Isidore hurricane, 2005



Stan hurricane, 2006



Wilma hurricane, 2006



Tabasco flooding, 2007

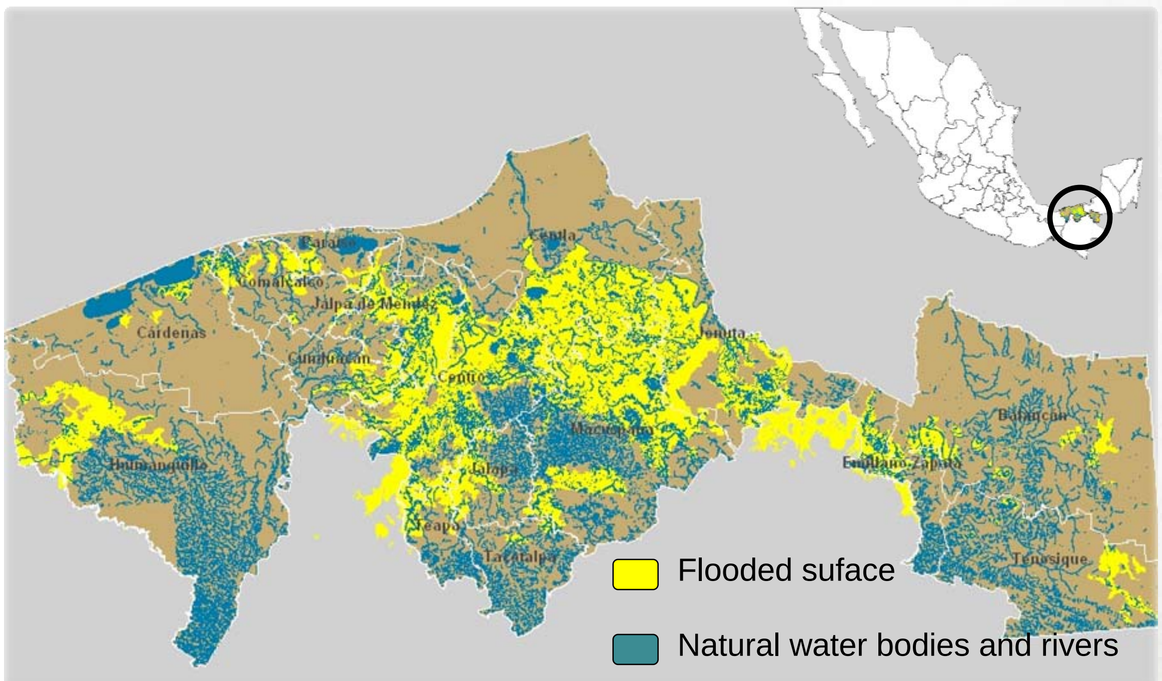
In October 2007, diverse factors as:

- Semi-stationary cold front Number 4,
- Tropical marine Air flow,
- Divergent air flow from the Pacific and
- A field of instability

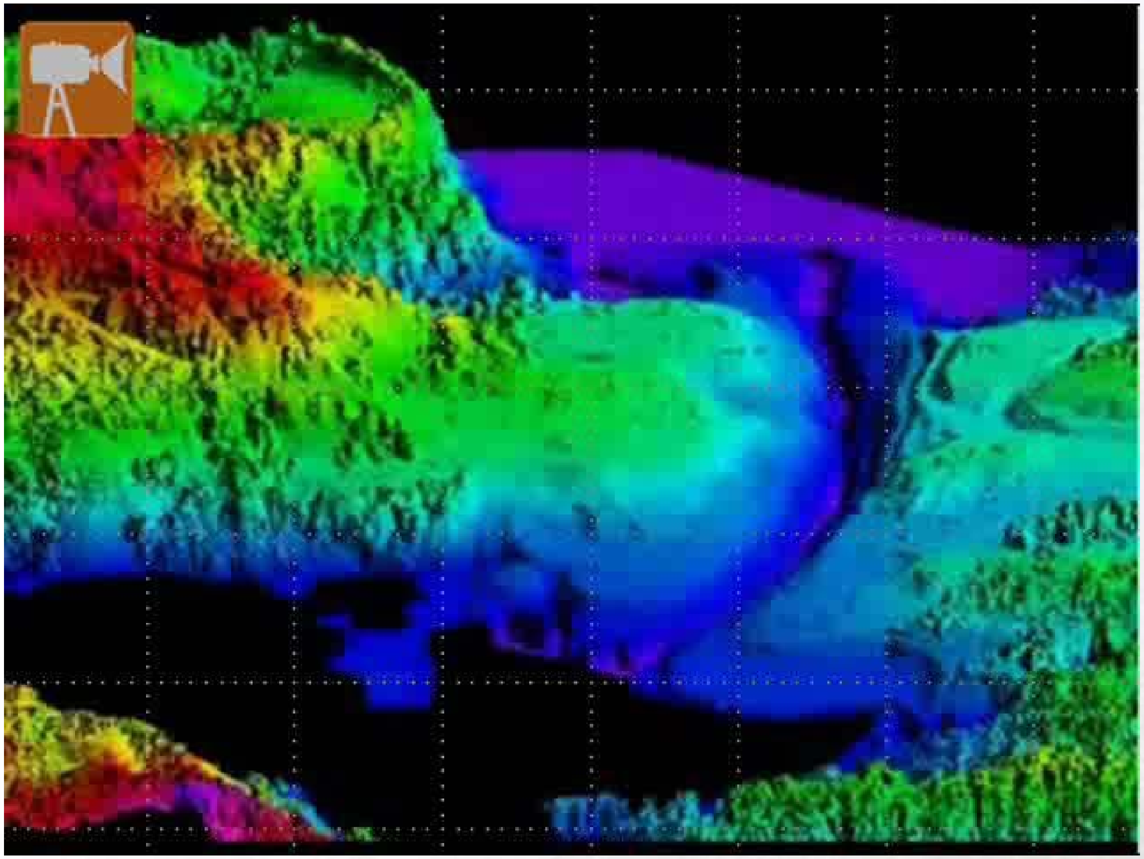
Produced the most intense rains in the Mexican Southeastern ever.

Outcome:

• Total state surface	almost 25 000 km^2
• Flooded surface	6 293 km^2
• Damaged population	545 870 inhabitants
• Damaged houses	134 610 houses
• Damaged economic establishments	13 088 establishments



This is an example of the LIDAR survey (digital terrain model) made on the Peñitas dam, where an avalanche buried the locality of Juan de Grijalva.



Present and Future Actions

To maintain updated the geographical information.

To strengthen the institutional participation.

To consolidate the interoperability of the Geography and Environment Subsystem by using our normative framework.

To support the sustainable development with information that leads to intelligent decisions.

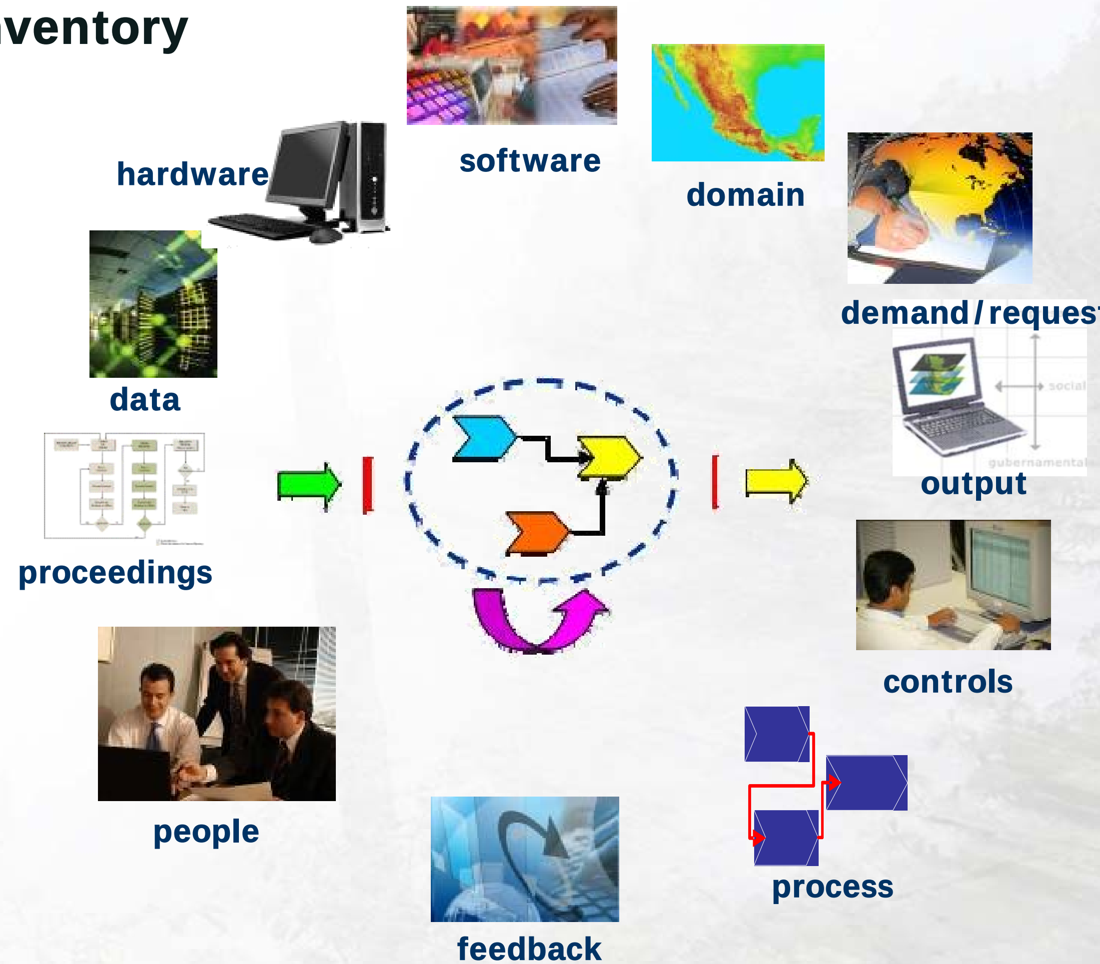
Atlas Nacional Interactivo de México

INEGI´s contribution to climate change adaptation

National active geodetic network

Natural resources inventory

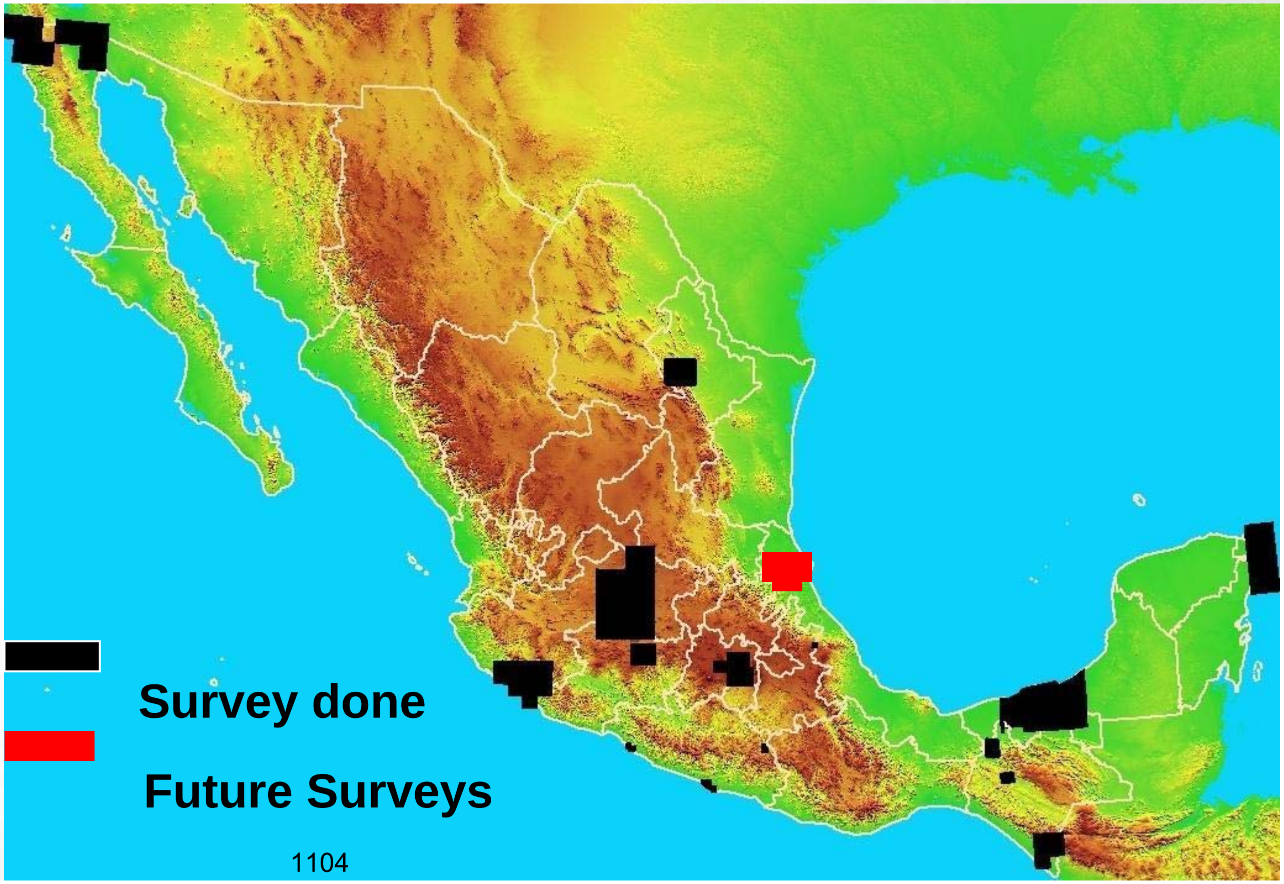
Censuses round

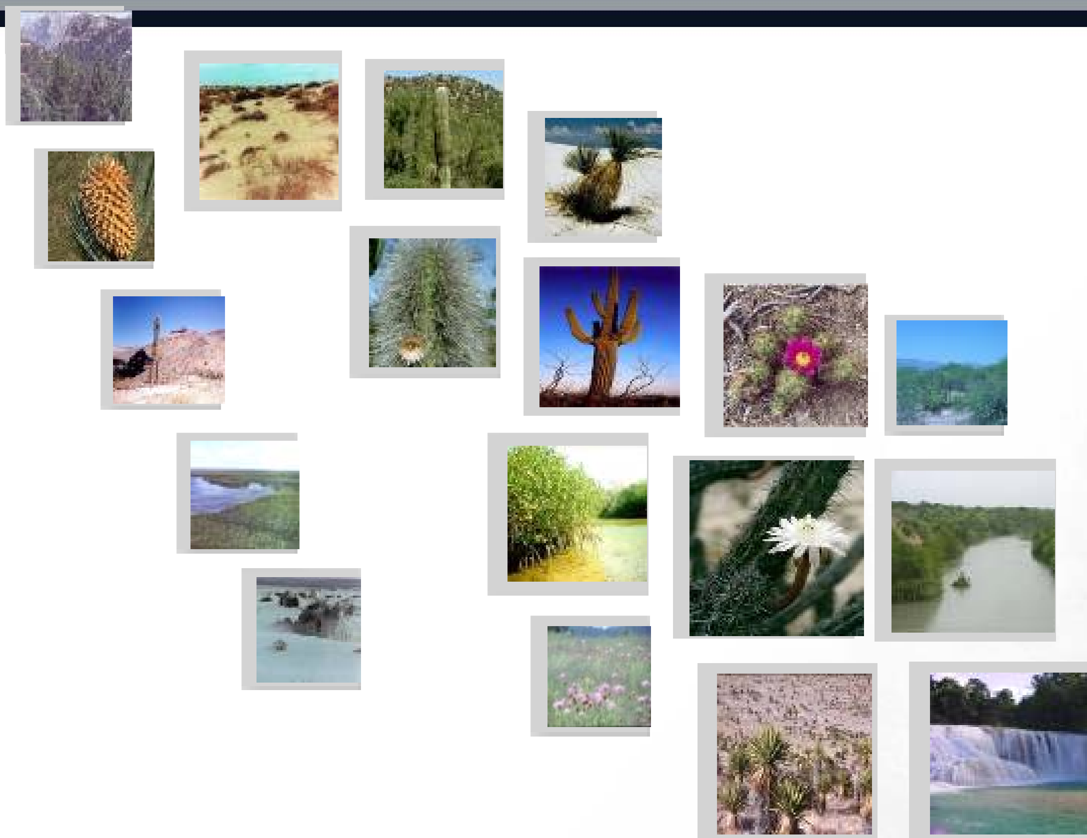


INEGI´s contribution to climate change mitigation

LIDAR survey in:

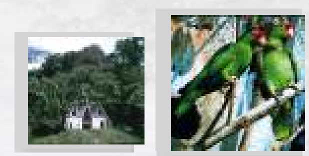
- **11 critical áreas**
- **Gulf of Mexico Coastal Plain (southern)**
- **Gulf of Mexico Coastal Plain (northern)**





"In the long term, the human being will only be able to survive on Earth, if we understand how to respect the physical, chemical and biological limits that assure our survival as species“

Louisse Lassonde



¡ GRACIAS !

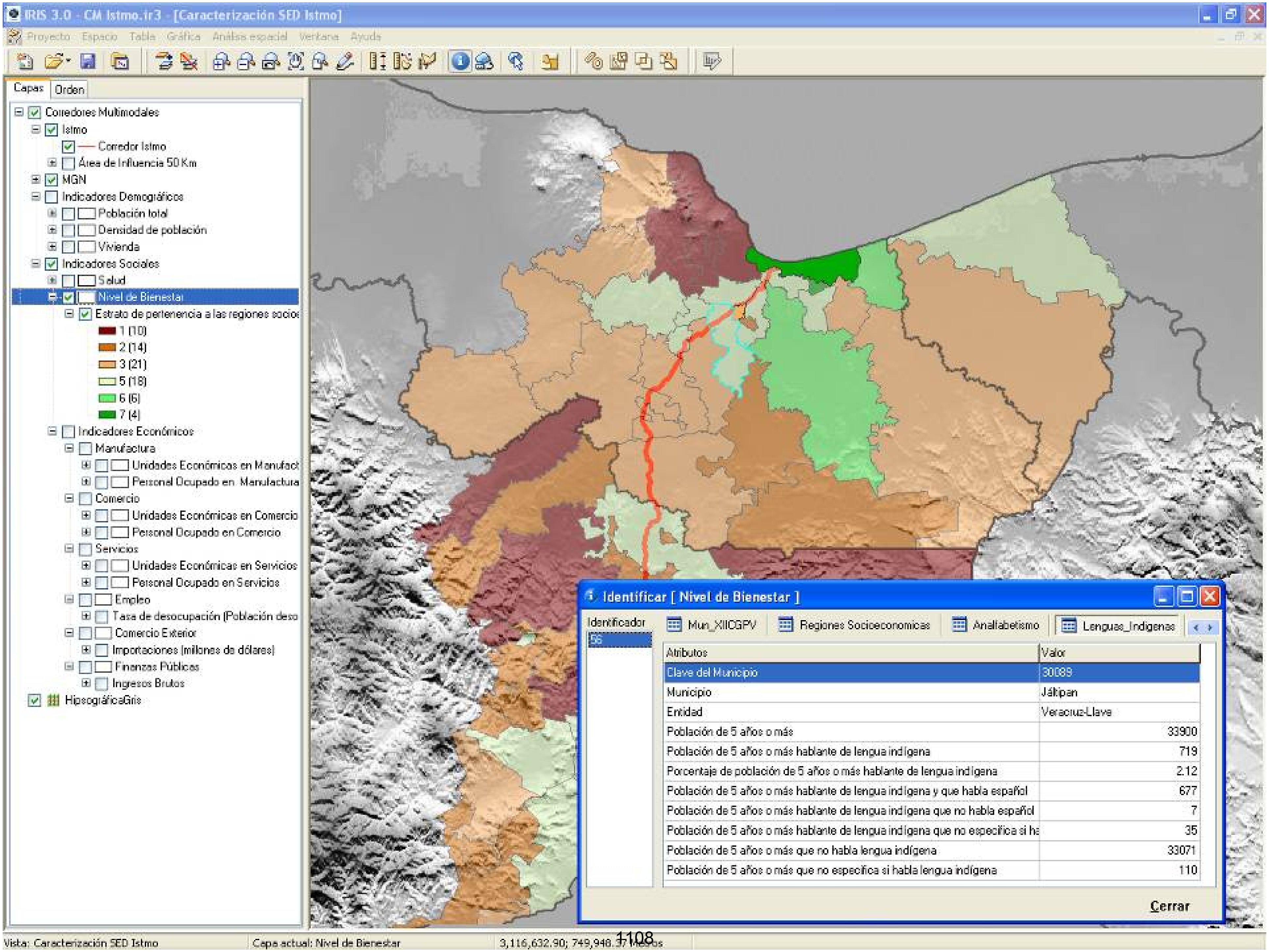
Dr. Gilberto Calvillo Vives

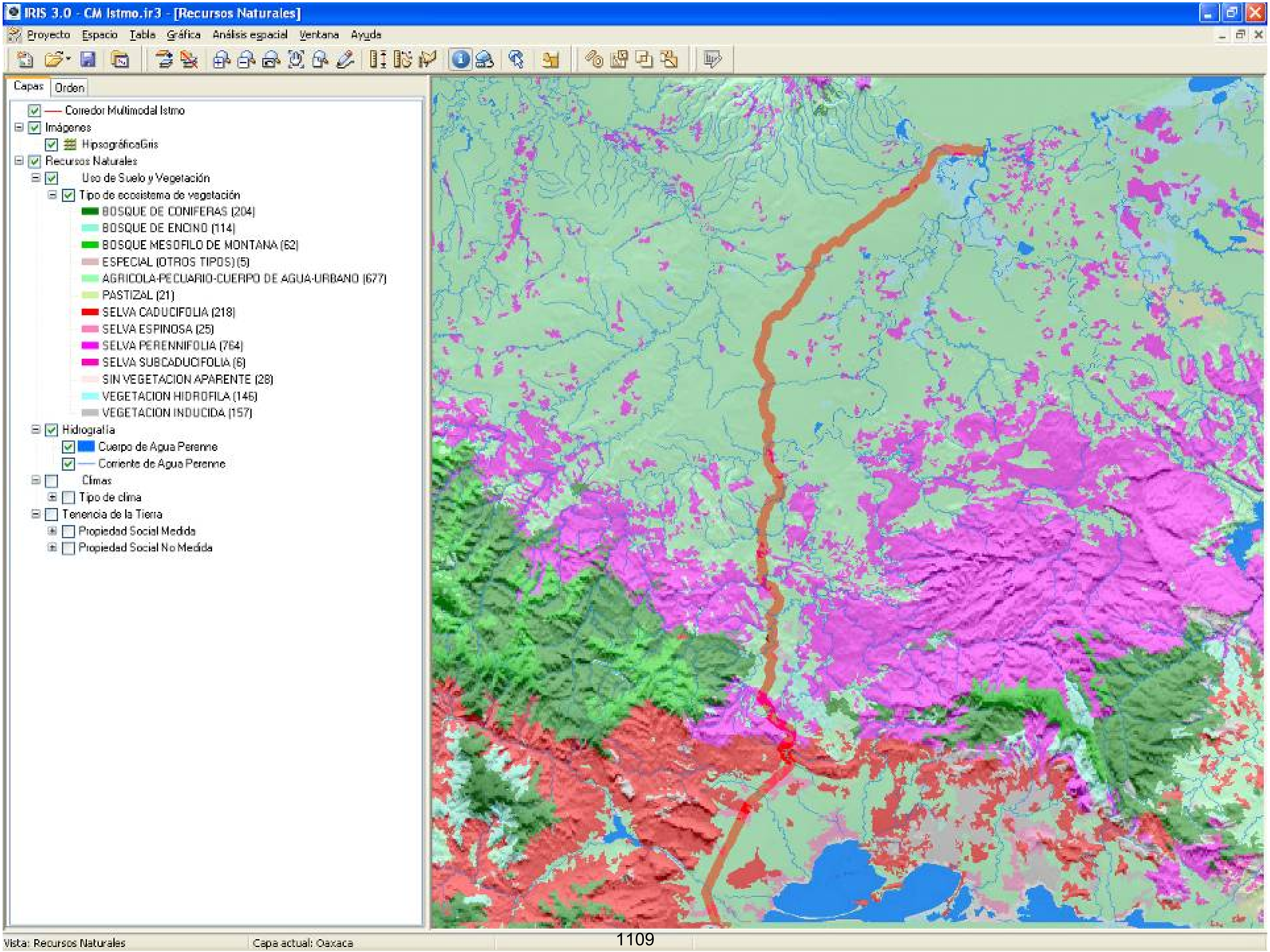
gilberto.calvillo@inegi.gob.mx

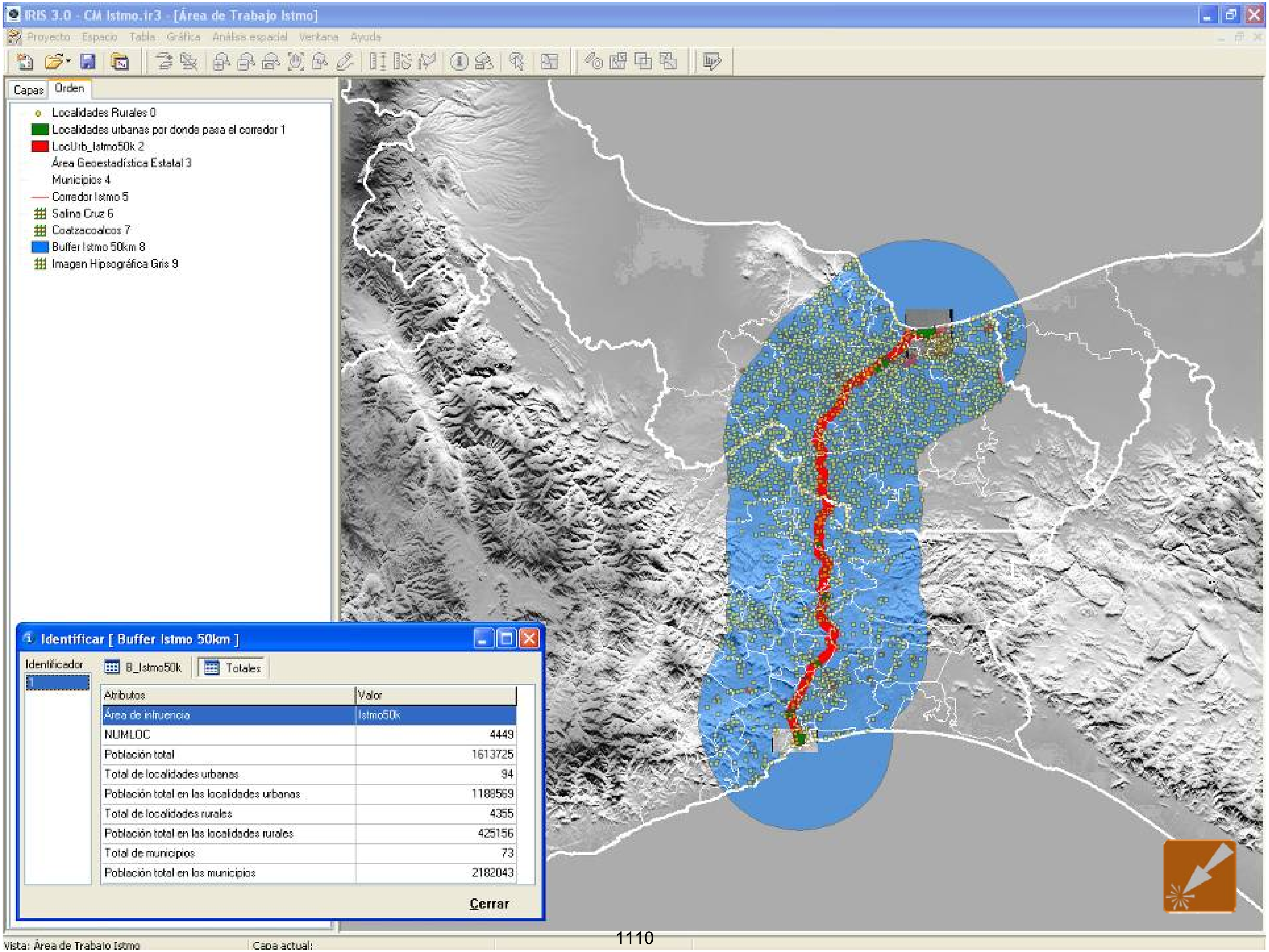
¡ THANK YOU !

Dr. Gilberto Calvillo Vives

gilberto.calvillo@inegi.gob.mx


IRIS 3.0 - CM Istmo.ir3 - [Caracterización SED Istmo]
Proyecto Espacio Tabla Gráfica Análisis espacial Ventana Ayuda
Capas Orden
Corredores Multimodales
Istmo
Corredor Istmo
Área de Influencia 50 Km
MGN
Indicadores Demográficos
Población total
Densidad de población
Vivienda
Indicadores Sociales
Salud
Nivel de Bienestar
Estrato de pertenencia a las regiones socio
1 (10)
2 (14)
3 (21)
5 (18)
6 (6)
7 (4)
Indicadores Económicos
Manufactura
Unidades Económicas en Manufact
Personal Ocupado en Manufactura
Comercio
Unidades Económicas en Comercio
Personal Ocupado en Comercio
Servicios
Unidades Económicas en Servicios
Personal Ocupado en Servicios
Empleo
Tasa de desocupación (Población deso
Comercio Exterior
Importaciones (millones de dólares)
Finanzas Públicas
Ingresos Brutos
HipsográficaGris
Identificar [Nivel de Bienestar]
Identificador
56
Mun_XIICGPV
Regiones Socioeconomicas
Analfabetismo
Lenguas_Indigenas
Atributos | Valor
Clave del Municipio | 30089
Municipio | Jáltipan
Entidad | Veracruz-Llave
Población de 5 años o más | 33900
Población de 5 años o más hablante de lengua indígena | 719
Porcentaje de población de 5 años o más hablante de lengua indígena | 2.12
Población de 5 años o más hablante de lengua indígena y que habla español | 677
Población de 5 años o más hablante de lengua indígena que no habla español | 7
Población de 5 años o más hablante de lengua indígena que no especifica si ha | 35
Población de 5 años o más que no habla lengua indígena | 33071
Población de 5 años o más que no especifica si habla lengua indígena | 110
Cerrar
Vista: Caracterización SED Istmo
Capa actual: Nivel de Bienestar
3,116,632.90; 749,948.37 Metros


IRIS 3.0 - CM Istmo.ir3 - [Recursos Naturales]
Proyecto Espacio Tabla Gráfica Análisis espacial Ventana Ayuda
Capas Orden
Corredor Multimodal Istmo
Imágenes
HipsográficaGris
Recursos Naturales
Uso de Suelo y Vegetación
Tipo de ecosistema de vegetación
BOSQUE DE CONIFERAS (204)
BOSQUE DE ENCINO (114)
BOSQUE MESOFILO DE MONTANA (62)
ESPECIAL (OTROS TIPOS) (5)
AGRICOLA-PECUARIO-CUERPO DE AGUA-URBANO (677)
PASTIZAL (21)
SELVA CADUCIFOLIA (218)
SELVA ESPINOSA (25)
SELVA PERENNIFOLIA (764)
SELVA SUBCADUCIFOLIA (6)
SIN VEGETACION APARENTE (28)
VEGETACION HIDROFILA (146)
VEGETACION INDUCIDA (157)
Hidrografía
Cuerpo de Agua Perenne
Corriente de Agua Perenne
Climas
Tipo de clima
Tenencia de la Tierra
Propiedad Social Medida
Propiedad Social No Medida
Vista: Recursos Naturales
Capa actual: Oaxaca

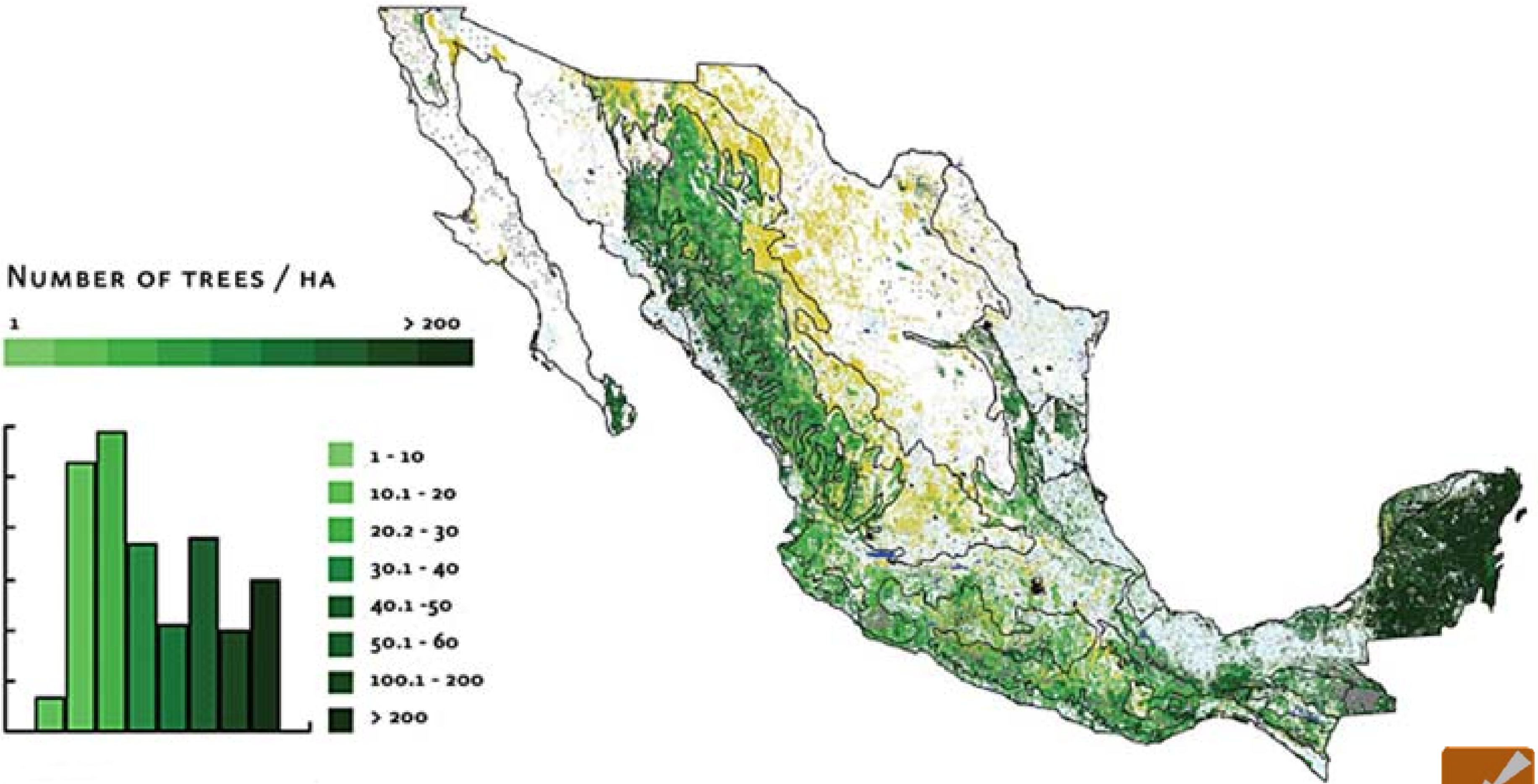

IRIS 3.0 - CM Istmo.ir3 - [Área de Trabajo Istmo]
Proyecto Espacio Tabla Gráfica Análisis espacial Ventana Ayuda
Capas
Orden
Localidades Rurales 0
Localidades urbanas por donde pasa el corredor 1
LocUrb_Istmo50k 2
Área Geoestadística Estatal 3
Municipios 4
Corredor Istmo 5
Salina Cruz 6
Coatzacoalcos 7
Buffer Istmo 50km 8
Imagen Hipsográfica Gris 9
Identificar [Buffer Istmo 50km]
Identificador
1
B_Istmo50k
Totales
Atributos
Valor
Área de influencia
Istmo50k
NUMLOC
4449
Población total
1613725
Total de localidades urbanas
94
Población total en las localidades urbanas
1188569
Total de localidades rurales
4355
Población total en las localidades rurales
425156
Total de municipios
73
Población total en los municipios
2182043
Cerrar
Vista: Área de Trabajo Istmo
Capa actual:

Basins and hydrographic network

Agriculture

	1980´s km²	1990´s km²	2000´s km²
Irrigated	73 480	85 071	92 456
Rainfed	186 847	205 788	216 837

Frequency in reforestation



Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

Climate Change and Indicators of Sustainable Development

Matthias Bruckner
Division for Sustainable Development
Department of Economic and Social Affairs
United Nations

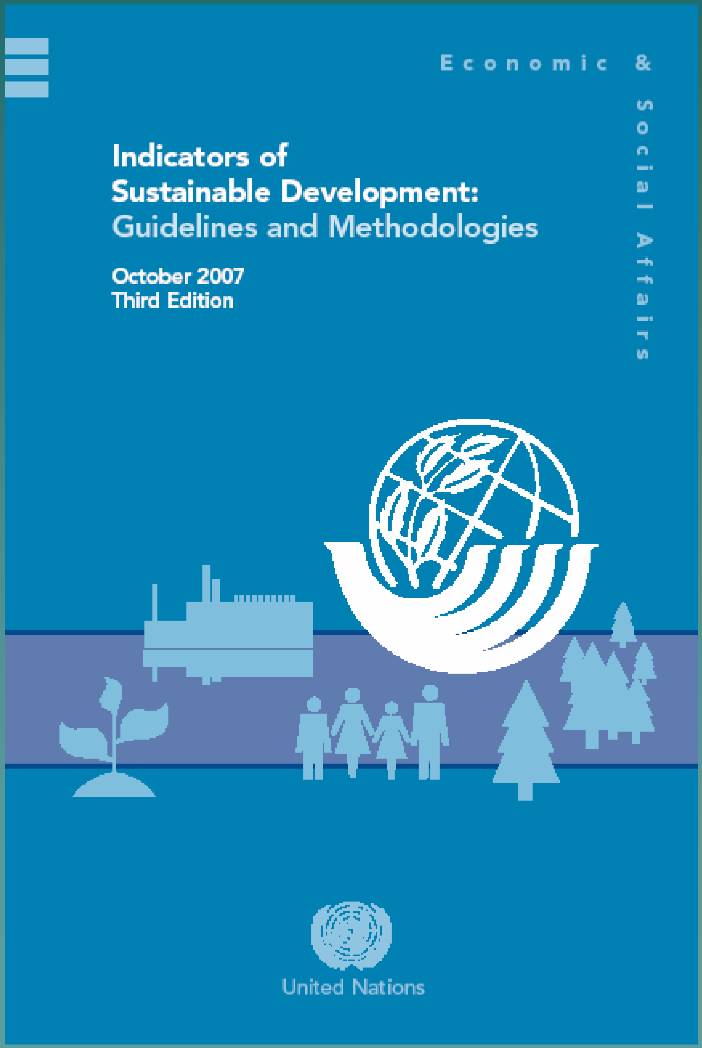
Outline

1. CSD Indicators of Sustainable Development
2. Indicators of Sustainable Development as framework for climate change indicators
3. Climate change related CSD indicators
4. Major area of future work: Climate change indicators on technology transfer

CSD Indicators of Sustainable Development: Purpose and origin

- The CSD indicators serve as reference for countries to develop national indicators of sustainable development.
- The importance of indicators for making informed decisions concerning sustainable development has been recognized in Agenda 21.
- The United Nations Commission on Sustainable Development (CSD) mandated the development of Indicators of Sustainable Development in 1995.
- The first and second edition were published in 1996 and 2001, after extensive testing by many countries around the world.
- The CSD indicators were reviewed 2005-2007 by experts from countries and international organizations.

CSD Indicators of Sustainable Development: Publication



- The third edition has just been published.
- Detailed methodology sheets for each indicator available online.
- Methodology sheets will be updated regularly.
- http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm

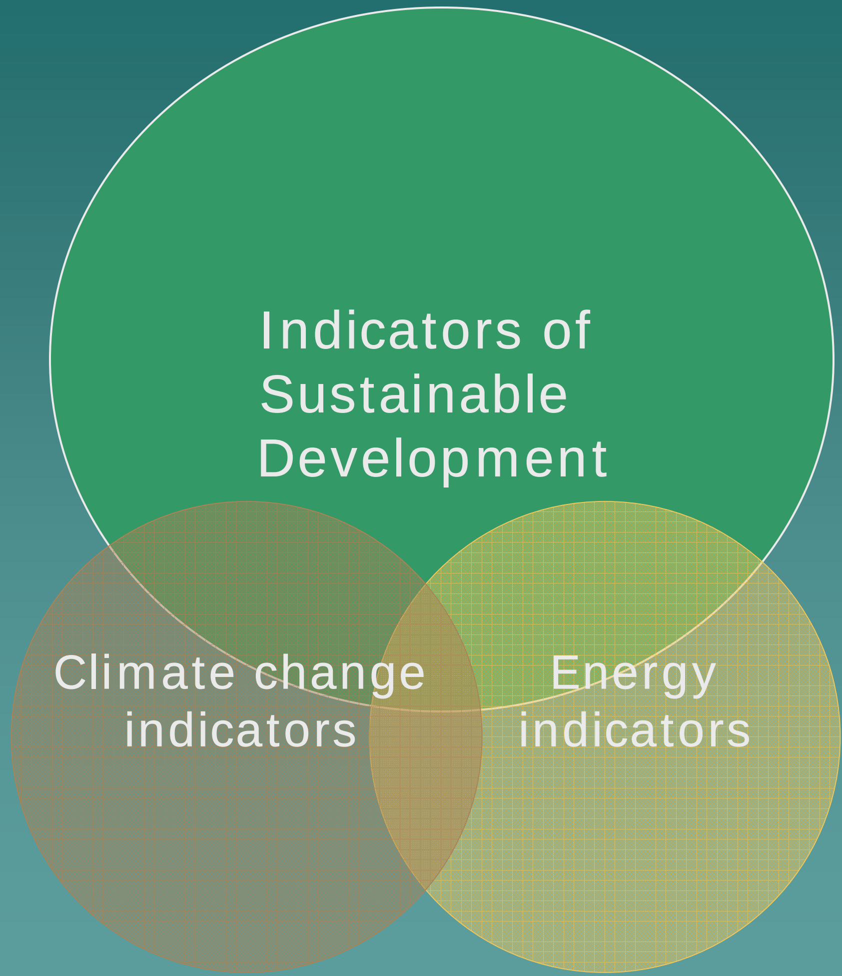
CSD Indicators of Sustainable Development: Main features

- The CSD indicators consist of 96 indicators of sustainable development, of which 50 are regarded as core indicators.
- The CSD-ISD are organized in 15 themes with 44 sub-themes.
- Indicator themes:
  - Poverty
  - Governance
  - Health
  - Education
  - Demographics
  - Atmosphere
  - Land
  - Oceans, seas, coasts
  - Freshwater
  - Biodiversity
  - Economic Development
  - Equity
  - Global partnership
  - Consumption and production patterns

Indicators of Sustainable Development as a framework

- Climate change is a sustainable development issue.
  - Indicators of Sustainable Development provide a natural framework.
- Existing sustainable development indicator sets are a useful point of departure for the derivation of climate change indicators.
  - It helps to recognize the important linkages between climate change and other sustainable development issues.
- Linking climate change indicators to sustainable development indicators increases coherence among indicator sets.
- It also helps to avoid duplication of efforts.
- Thematic, policy-oriented frameworks, used in most national sustainable development indicator sets as well as for CSD indicators, are very flexible.

Indicators of Sustainable Development as a framework



Climate change related CSD indicators

- Many CSD indicators are directly or indirectly related to climate change.
- Due to the cross-cutting nature of climate change, these indicators are placed in various themes and sub-themes.
- They utilize a variety of data sources:
  - National accounts, business statistics, geographical information systems, administrative data, surveys, census, estimations, expert assessments (carefully reviewed).
- The following tables are based on work-in-progress.

Climate change related CSD indicators
Climate change mitigation

- Theme: Atmosphere

Sub-theme	*Indicator*	*Climate change link*
Climate change	CO_2 emissions	CO_2 is the main GHG, indicator broken down by (UNFCCC) sector
	GHG emissions	All six major GHG
Ozone layer depletion	Consumption of Ozone Depleting Substances	CFCs and HCFCs contribute to global warming

Climate change related CSD indicators
Climate change mitigation

- Theme: Land

Sub-theme	*Indicator*	*Climate change link*
Land use and status	Land use change	Major driver of CO_2 emissions; LULUCF is separate sector in UNFCCC
	Land degradation	Major cause of emissions from LULUCF
Forests	Percentage of land covered by forests	Major carbon sink, deforestation major source of CO_2 emissions
	Area under sustainable forest management	Sustainable managed forests have enhanced and longer carbon absorption potential
Agriculture	Area under organic farming	Lower emissions of N_2O, CH_4, and CO_2

Climate change related CSD indicators
Climate change mitigation

- Theme: Consumption and production patterns

Sub-theme	*Indicator*	*Climate change link*
Energy use	Annual energy consumption, total and by main user category	Energy conservation important element of most climate change strategies
	Share of renewable energy sources	Lower/no CO_2 emissions
	Intensity of energy use, total and by main economic activity	Energy efficiency important element of most climate change strategies
Transport	Energy intensity of transport (Energy per km)	Major factor for increasing emissions; fuel switching not considered
	Modal split of passenger transportation	Public transport generates lower emissions
	Modal split of freight transportation	Railway and inland waterways generate lower emissions

Climate change related CSD indicators
Climate change mitigation

- Theme: Consumption and production patterns

Sub-theme	*Indicator*	*Climate change link*
Waste generation and management	Waste treatment and disposal	Recycling and incineration have no significant emissions; emissions from landfills depend on management
	Waste generation	Waste reduction and reuse have lowest emissions and most sustainable development benefits
Material consumption	Domestic material consumption	Fossil fuels important component of DMC
	Material intensity of the economy	Measures progress of overall eco-efficiency

Climate change related CSD indicators
Climate change adaptation/vulnerability

- Theme: Natural hazards

Sub-theme	*Indicator*	*Climate change link*
Vulnerability to natural hazards	Percentage of population living in hazard prone areas (separated by hazard)	Drought, floods, landslides, cyclones are associated with climate change; earthquakes, volcanoes, tsunamis are not
	Human and economic los due to natural disasters	

- Theme: Land

Land use and status	Land degradation	Land degradation is both cause and consequence of climate change
Desertification	Land affected by desertification	Important negative impact of climate change

Climate change related CSD indicators
Climate change adaptation/vulnerability

- Theme: Biodiversity

Sub-theme	*Indicator*	*Climate change link*
Species	Change in threat status of species	Global warming major risk factor
	Abundance of invasive alien species	Global warming may lead to increase in IAS
Ecosystem	Proportion of terrestrial area protected, total and by ecological region	Effective protection of ecological regions limits negative impacts of climate change on ecosystems and species

- Theme: Health

Health status and risks	Morbidity of major diseases such as HIV/AIDS, malaria, TB	Climate change may cause increase in areas where malaria is endemic

Climate change related CSD indicators
Climate change adaptation/vulnerability

- Theme: Ocean, seas and coasts

Sub-theme	*Indicator*	*Climate change link*
Coastal zone	Percentage of population living in coastal areas	Vulnerability to sea-level rise and cyclones
Marine environment	Area of coral reef ecosystems and live cover	Global warming one of the major risk factors for coral reefs
	Proportion of marine area protected	Effective protection of ecological regions limits negative impacts of climate change on ecosystems and species

- Theme: Freshwater

Water quantity	Proportion of total water resources used	Climate change has negative impact on water availability
	Water use intensity by economic activity	Decrease in water intensity can be part of adaptation

Climate change related CSD indicators
Climate change adaptive capacity

- As sustainable development is a major factor of a country's capacity to adapt to climate change, many more CSD indicators are highly relevant for climate change.
- Examples include:
  - Proportion of population below national poverty line
  - Proportion of population using an improved water source
  - Proportion of urban population living in slums
  - Percent of population with access to primary health care facilities
  - Adult secondary (tertiary) schooling attainment level
  - GDP per capita

Climate change related CSD indicators

- Other possible climate change indicators could be linked to CSD indicators:

CSD indicator	*Climate change indicator*	*Comment*
Gross domestic expenditures on R&D as percent of GDP	Climate change related R&D expenditures	Requires definition of climate change related
Net ODA given or received	Climate change related ODA given or received	Data on UNFCCC related ODA exists from OECD/DAC
Arable and permanent cropland	Land productivity; area harvested by crop	Agriculture is a main affected sector
Investment share in GDP	Infrastructure investment in areas affected by climate change	Adaptation requires change in physical infrastructure and its management

Technology transfer and climate change indicators

- Development of climate change related indicators of technology transfer is a major area of work.
- Critical issues and challenge include:
  - Definition of climate-change related technologies;
  - Wide range of climate change related technologies, especially in the area of adaptation;
  - Technology transfer includes flow of equipment (technology goods; embodied technologies), experiences and know-how (disembodied technologies), capacities to apply technology (finance, skills,…).

Technology transfer and climate change indicators -Possible sources

- Merchandise trade
  - Covers embodied technologies only;
  - Measured in value terms
    - May fail to capture effects of changing terms,
    - Decline of indicator value could be due to less trade or more preferential terms;
  - First proposals made in the Doha negotiations under the World Trade Organization.

Technology transfer and climate change indicators -Possible sources

- Merchandise trade (cont'd)
  - – Type of proposals:
  - – List approach, but lists of climate change technologies remain highly controversial;
  - – Request-and-offer approach to find compromise acceptable for all,
    - HS classification at the 6-digit level could be too coarse (holds for both approaches);
  - – Project approach to address concerns on dual use of technologies,
    - Would probably require use of customs rather than merchandise trade statistics.

Technology transfer and climate change indicators -Possible sources

- Trade in services
  - General Agreement on Trade in Services under the WTO includes “Environmental services”;
  - Royalties and fees excluded from GATS, but available from Balance of Payments;
  - Intra-firm trade in services is major form of transfer of know-how and experiences,
    - Foreign Affiliates Trade in Services Statistics (FATS) not widely used,
    - Inward FDI facilitates inflows of experiences and know-how,
    - Outward FDI can provide access to know-how and experiences;
  - Temporary presence abroad (e.g., studying, training) is also important for transfer of know-how and experiences.

Technology transfer and climate change indicators -Possible sources

- Current and possible future data on mechanisms related to the UNFCCC
  - Projects under the flexible mechanisms under the Kyoto Protocol (JI, CDM) often involve transfer of technology, but difficult to quantify.
  - Other modalities are possible (e.g., technology transfer fund) to ensure that technology transfer is measurable, reportable and verifiable.

Thank You

Contact: Matthias Bruckner
Division for Sustainable Development
Department of Economic and Social Affairs
United Nations

email: brucknerm@un.org
http://www.un.org/esa/sustdev/index.html

United Nations
Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

The UK Sustainable Development Indicator System

Stephen Hall
Department for Environment, Food and Rural Affairs, United Kingdom

defra
Department for Environment Food and Rural Affairs

NATIONAL STATISTICS

Securing the future
delivering UK sustainable development strategy

Headlines

Evening Standard

Crime up, roads worse but life is better says Labour

Securing the future
delivering UK sustainable development strategy

Headlines

THE TIMES

Life is better despite crime, illness and cars, says Labour

Securing the future
delivering UK sustainable development strategy

Headlines

Eveni

THE TIMES

The Express

Quality of life is better? But what about all the thugs and the jams

Securing the future
delivering UK sustainable development strategy

Headlines

Securing the future
delivering UK sustainable development strategy

Why do we think we need indicators?

- Summarise and simplify?
- Help focus on specific issues?
- Report on progress?
- Inform decision making?
- Drive policy development?
- Raise awareness / wider engagement?
- To hold accountable?

Securing the future
delivering UK sustainable development strategy

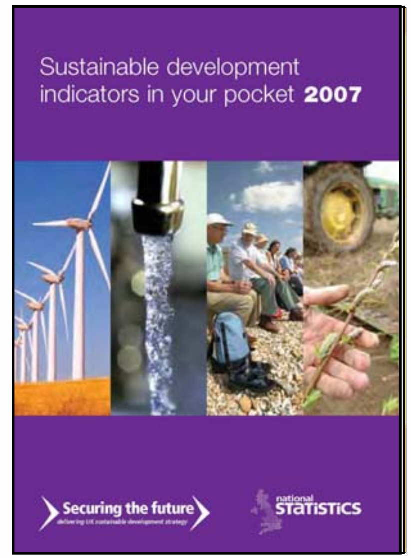
Challenges

- Expectations of indicators
- Different audiences
- Integration in policy making
- Integration between indicators
- Plethora of indicators and targets
- Assessment approach

Securing the future
delivering UK sustainable development strategy

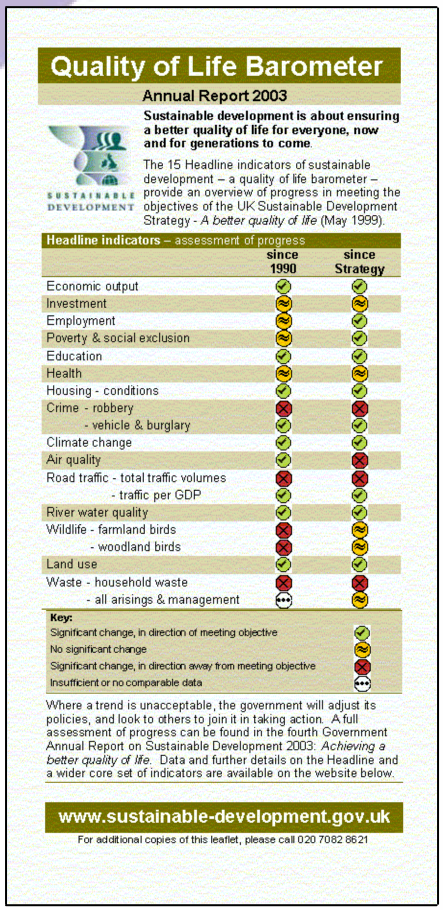
Policy frameworks & indicators

- 1994 - *The UK Strategy*
- 1996 - *Indicators of SD (120)*
- 1999 - *A better quality of life*
- 1999 - *Quality of life counts (147)*
- 2005 - *Securing the future*
- 2005 - *Framework / Strategy indicators (68)*



Securing the future
delivering UK sustainable development strategy

Communication - leaflets



Quality of Life Barometer

Annual Report 2003

Sustainable development is about ensuring a better quality of life for everyone, now and for generations to come.

The 15 Headline indicators of sustainable development – a quality of life barometer – provide an overview of progress in meeting the objectives of the UK Sustainable Development Strategy - *A better quality of life* (May 1999).

Headline indicators – assessment of progress

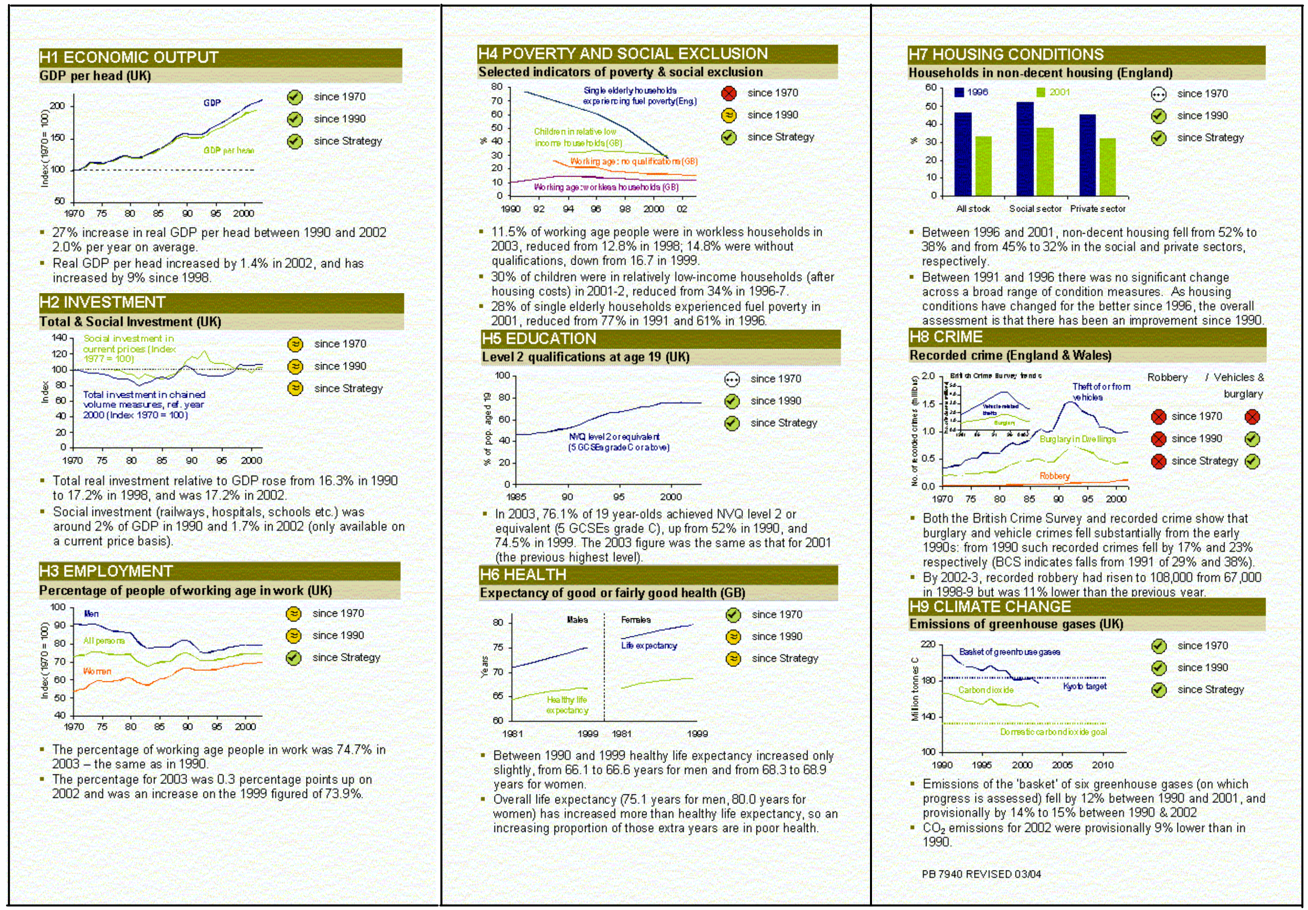
	since 1990	since Strategy
Economic output	✓	✓
Investment	≈	≈
Employment	≈	✓
Poverty & social exclusion	≈	✓
Education	✓	✓
Health	≈	≈
Housing - conditions	✓	✓
Crime - robbery	✗	✗
- vehicle & burglary	✓	✓
Climate change	✓	✓
Air quality	✓	✗
Road traffic - total traffic volumes	✗	✗
- traffic per GDP	✓	✓
River water quality	✓	✓
Wildlife - farmland birds	✗	≈
- woodland birds	✗	≈
Land use	✓	✓
Waste - household waste	✗	✗
- all arisings & management	•••	≈

Key:
Significant change, in direction of meeting objective ✓
No significant change ≈
Significant change, in direction away from meeting objective ✗
Insufficient or no comparable data •••

Where a trend is unacceptable, the government will adjust its policies, and look to others to join it in taking action. A full assessment of progress can be found in the fourth Government Annual Report on Sustainable Development 2003: *Achieving a better quality of life*. Data and further details on the Headline and a wider core set of indicators are available on the website below.

www.sustainable-development.gov.uk

For additional copies of this leaflet, please call 020 7082 8621



H1 ECONOMIC OUTPUT
GDP per head (UK)

- 27% increase in real GDP per head between 1990 and 2002 2.0% per year on average.
- Real GDP per head increased by 1.4% in 2002, and has increased by 9% since 1998.

H2 INVESTMENT
Total & Social Investment (UK)

- Total real investment relative to GDP rose from 16.3% in 1990 to 17.2% in 1998, and was 17.2% in 2002.
- Social investment (railways, hospitals, schools etc.) was around 2% of GDP in 1990 and 1.7% in 2002 (only available on a current price basis).

H3 EMPLOYMENT
Percentage of people of working age in work (UK)

- The percentage of working age people in work was 74.7% in 2003 – the same as in 1990.
- The percentage for 2003 was 0.3 percentage points up on 2002 and was an increase on the 1999 figured of 73.9%.

H4 POVERTY AND SOCIAL EXCLUSION
Selected indicators of poverty & social exclusion

- 11.5% of working age people were in workless households in 2003, reduced from 12.8% in 1998; 14.8% were without qualifications, down from 16.7 in 1999.
- 30% of children were in relatively low-income households (after housing costs) in 2001-2, reduced from 34% in 1996-7.
- 28% of single elderly households experienced fuel poverty in 2001, reduced from 77% in 1991 and 61% in 1996.

H5 EDUCATION
Level 2 qualifications at age 19 (UK)

- In 2003, 76.1% of 19 year-olds achieved NVQ level 2 or equivalent (5 GCSEs grade C), up from 52% in 1990, and 74.5% in 1999. The 2003 figure was the same as that for 2001 (the previous highest level).

H6 HEALTH
Expectancy of good or fairly good health (GB)

- Between 1990 and 1999 healthy life expectancy increased only slightly, from 66.1 to 66.6 years for men and from 68.3 to 68.9 years for women.
- Overall life expectancy (75.1 years for men, 80.0 years for women) has increased more than healthy life expectancy, so an increasing proportion of those extra years are in poor health.

H7 HOUSING CONDITIONS
Households in non-decent housing (England)

- Between 1996 and 2001, non-decent housing fell from 52% to 38% and from 45% to 32% in the social and private sectors, respectively.
- Between 1991 and 1996 there was no significant change across a broad range of condition measures. As housing conditions have changed for the better since 1996, the overall assessment is that there has been an improvement since 1990.

H8 CRIME
Recorded crime (England & Wales)

- Both the British Crime Survey and recorded crime show that burglary and vehicle crimes fell substantially from the early 1990s: from 1990 such recorded crimes fell by 17% and 23% respectively (BCS indicates falls from 1991 of 29% and 38%).
- By 2002-3, recorded robbery had risen to 108,000 from 67,000 in 1998-9 but was 11% lower than the previous year.

H9 CLIMATE CHANGE
Emissions of greenhouse gases (UK)

- Emissions of the 'basket' of six greenhouse gases (on which progress is assessed) fell by 12% between 1990 and 2001, and provisionally by 14% to 15% between 1990 & 2002
- CO_2 emissions for 2002 were provisionally 9% lower than in 1990.

PB 7940 REVISED 03/04

Securing the future
delivering UK sustainable development strategy

Communication - leaflets

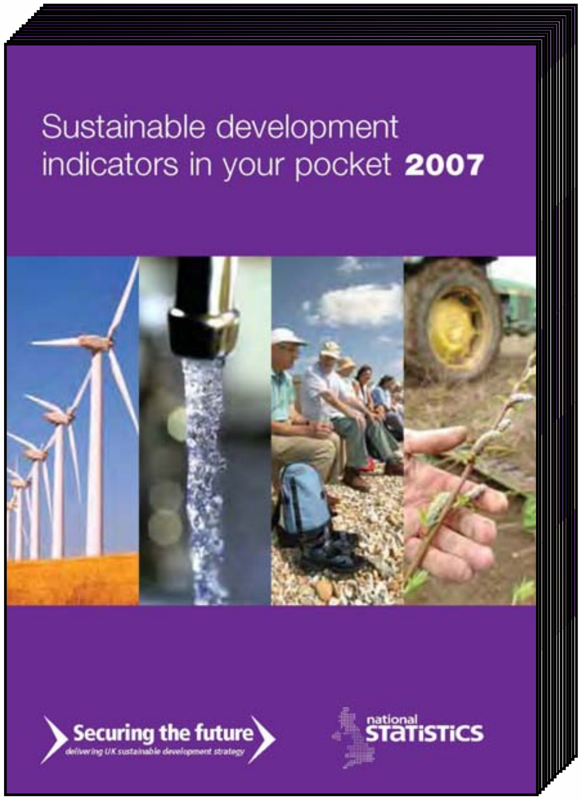
- Described in 2001 by a UK Commissioner for Sustainable Development as

  "The single most important development in the communication of sustainable development"

- Emulated by others, including:
  - *European Commission / Eurostat*
  - *Environment Agency (England & Wales)*
  - *Finnish Environment Institute*

Securing the future
delivering UK sustainable development strategy

Indicators in your pocket



- 68 indicators
- Simple presentation
- ‘Traffic light’ assessments
- Pie-chart summaries
- 55,000 copies since July

Securing the future
delivering UK sustainable development strategy

Hard work in the background

- Stakeholder consultation / workshops
- Reviewing existing indicators
- Developing an indicator framework
- Cross-government consultation / agreement
- Collating data annually for all the measures
- Agreeing assessments of progress
- Publication
- Developing new indicators
  (most recently wellbeing)

Securing the future
delivering UK sustainable development strategy

Indicator framework

Sustainable consumption & production

Climate change & energy

Natural resource protection & enhancement

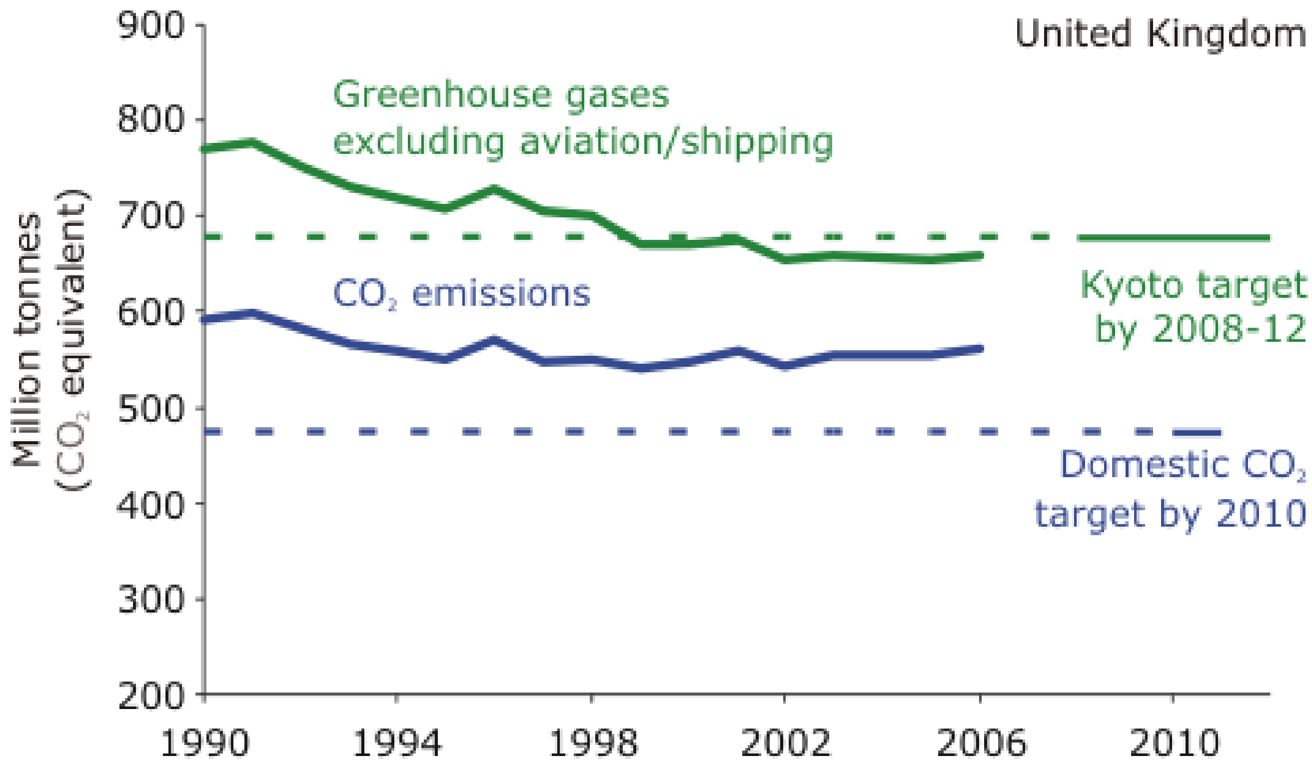
Creating sustainable communities & a fairer world

Decoupling emissions, resource use & waste

Society
Employment & poverty
Education
Health
Mobility & access
Justice & equity
Housing
Wellbeing
International
Contextual

Securing the future
delivering UK sustainable development strategy

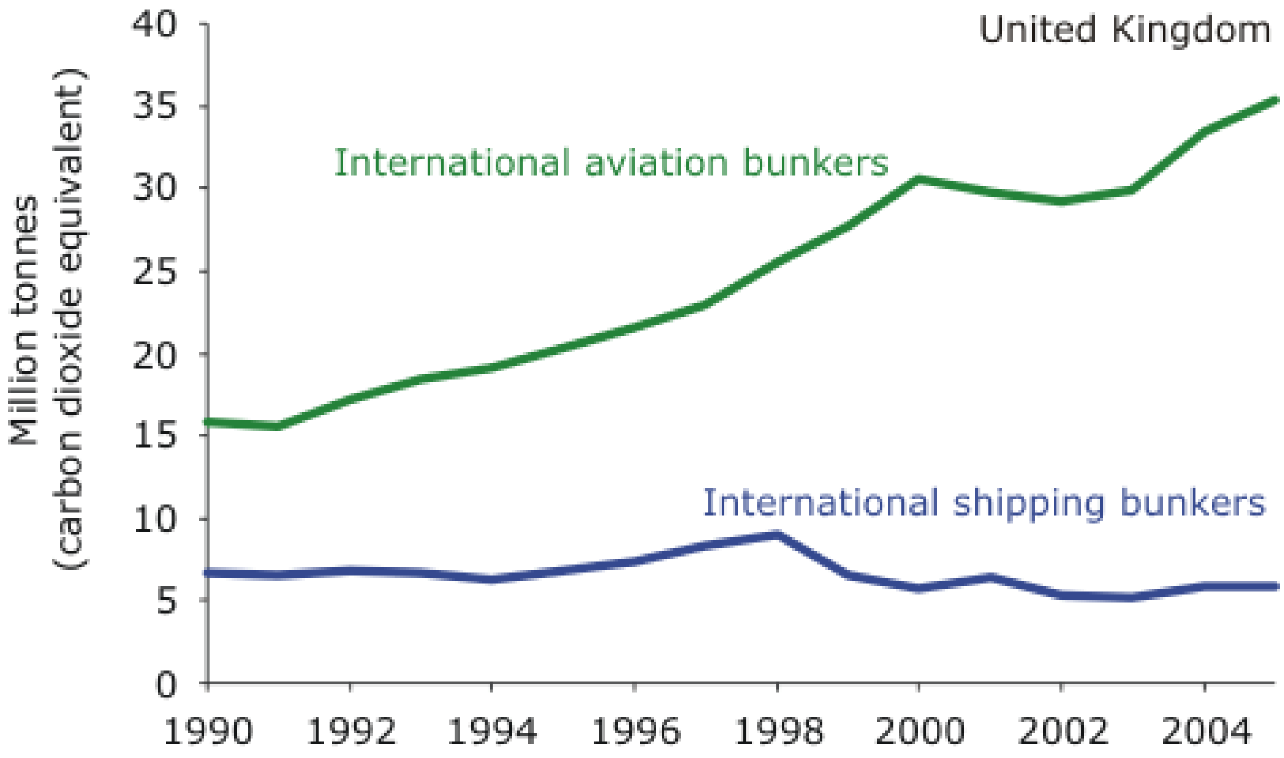
Greenhouse gas emissions



Source: Defra, BERR, AEA Energy and Environment

Securing the future
delivering UK sustainable development strategy

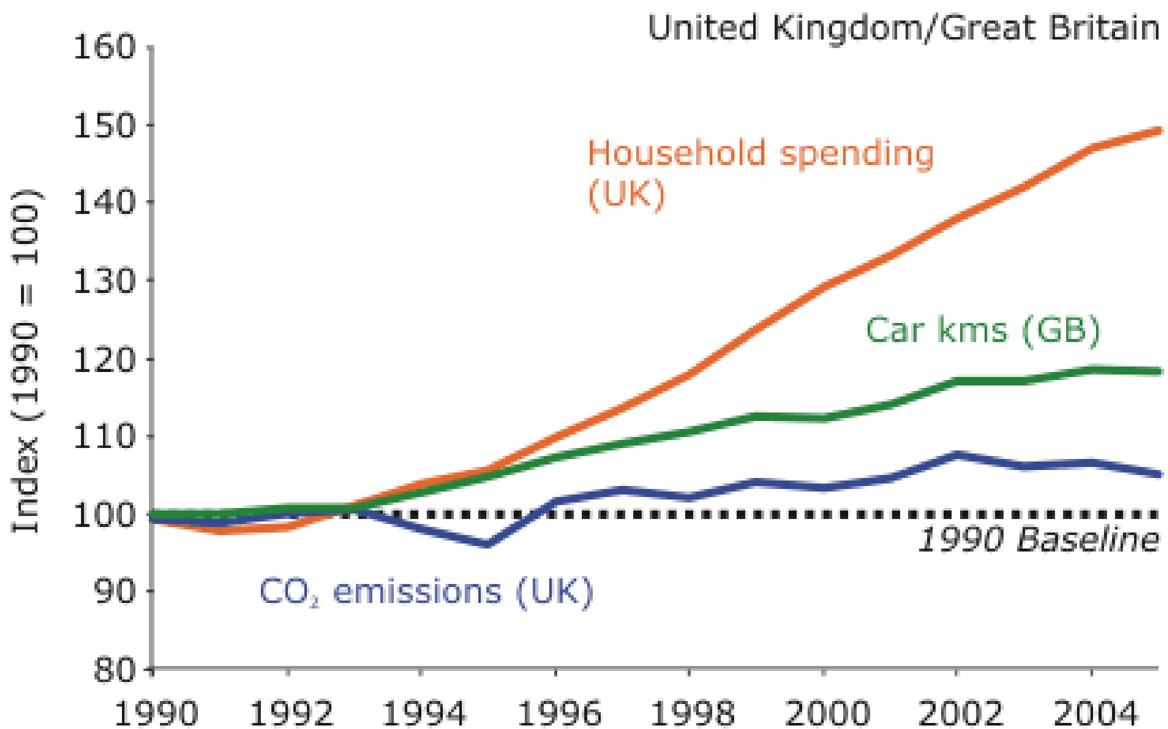
Aviation & shipping emissions



Source: AEA Energy and Environment

Securing the future
delivering UK sustainable development strategy

Private car CO_2 emissions

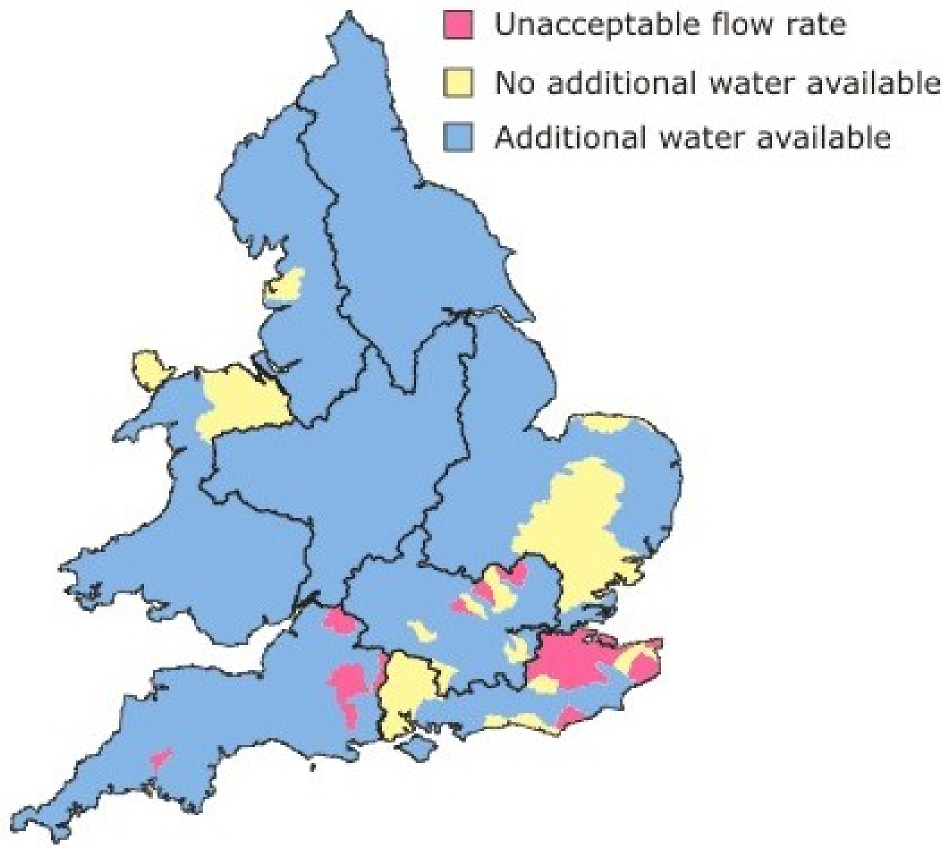


Notes: Data for 1993 onwards are not directly comparable with figures for 1992 and earlier.

Source: ONS, DfT

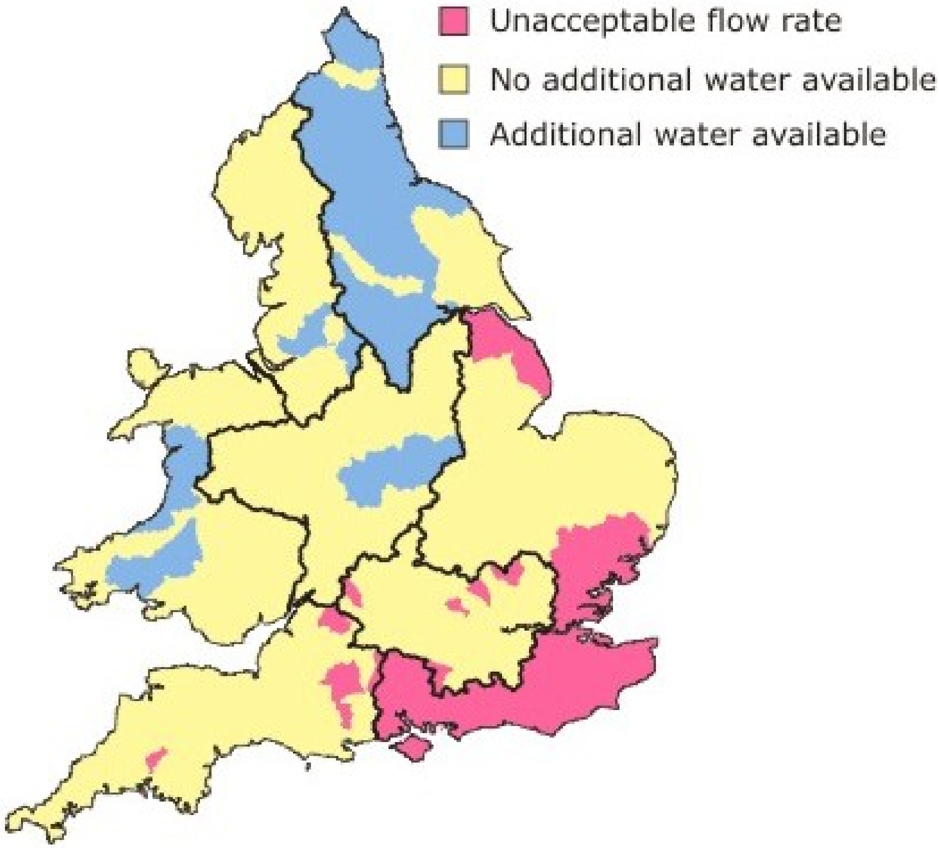
Securing the future
delivering UK sustainable development strategy

Water stress - winter

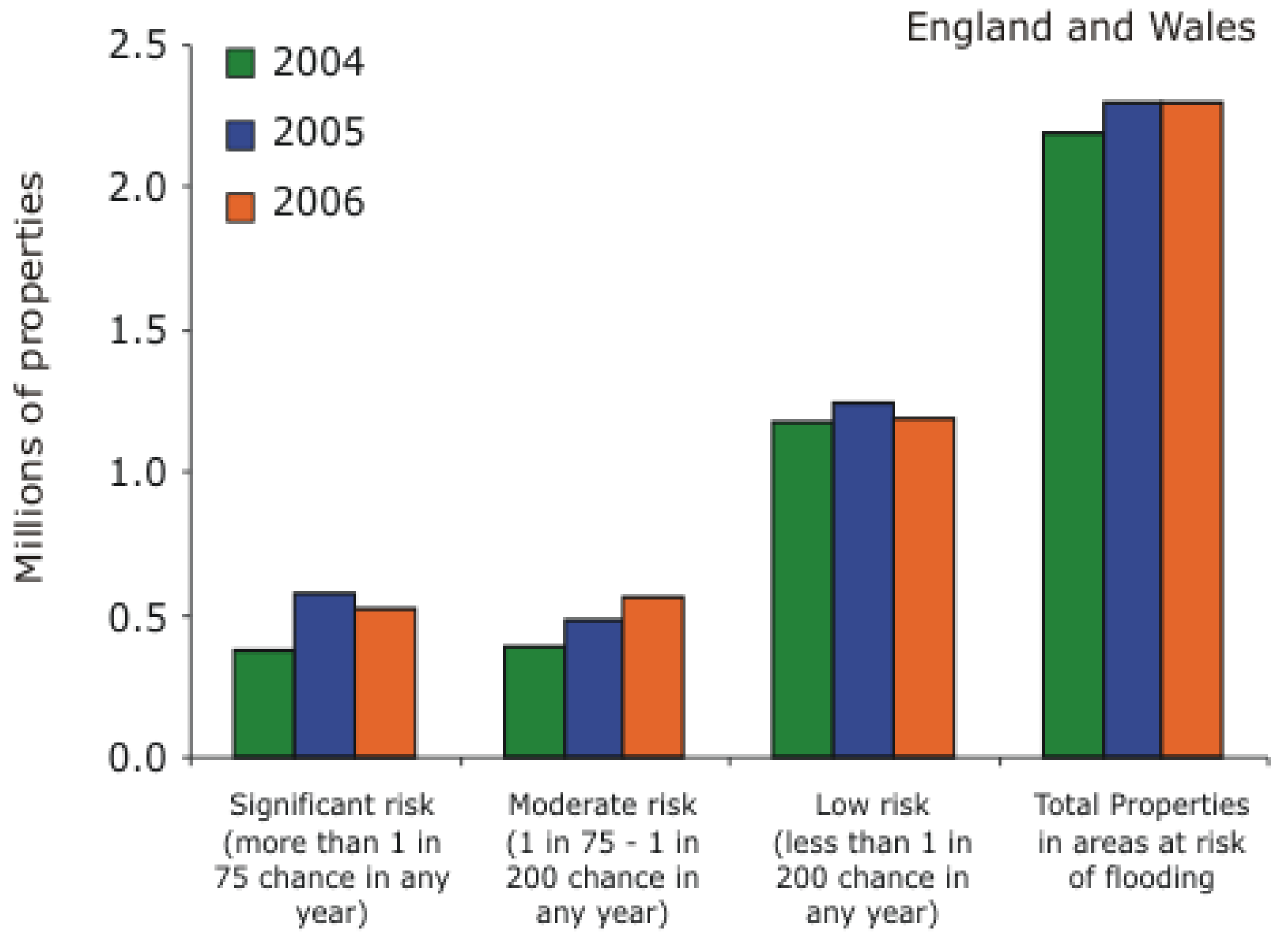


Securing the future
delivering UK sustainable development strategy

Water stress - summer



Properties at risk of flooding

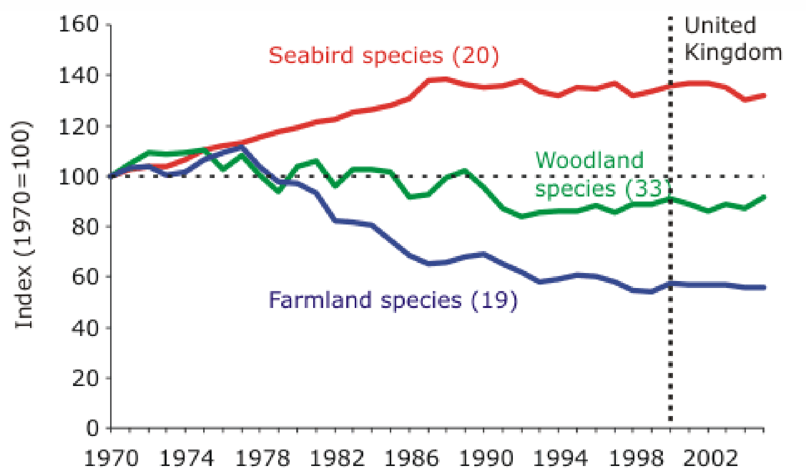


Source: EA, Defra

Securing the future
delivering UK sustainable development strategy

Other indicators

- Sectoral emission ‘decoupling’ indicators
- Renewable energy
- Electricity generation and emissions
- Adaptation? Bird populations

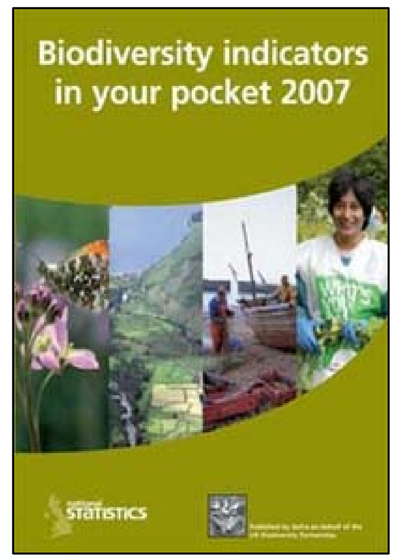


Note: Figures in brackets show the number of species included in each category.
Source: Royal Society for the Protection of Birds, British Trust for Ornithology, Defra, Joint Nature Conservation Committee

Securing the future
delivering UK sustainable development strategy

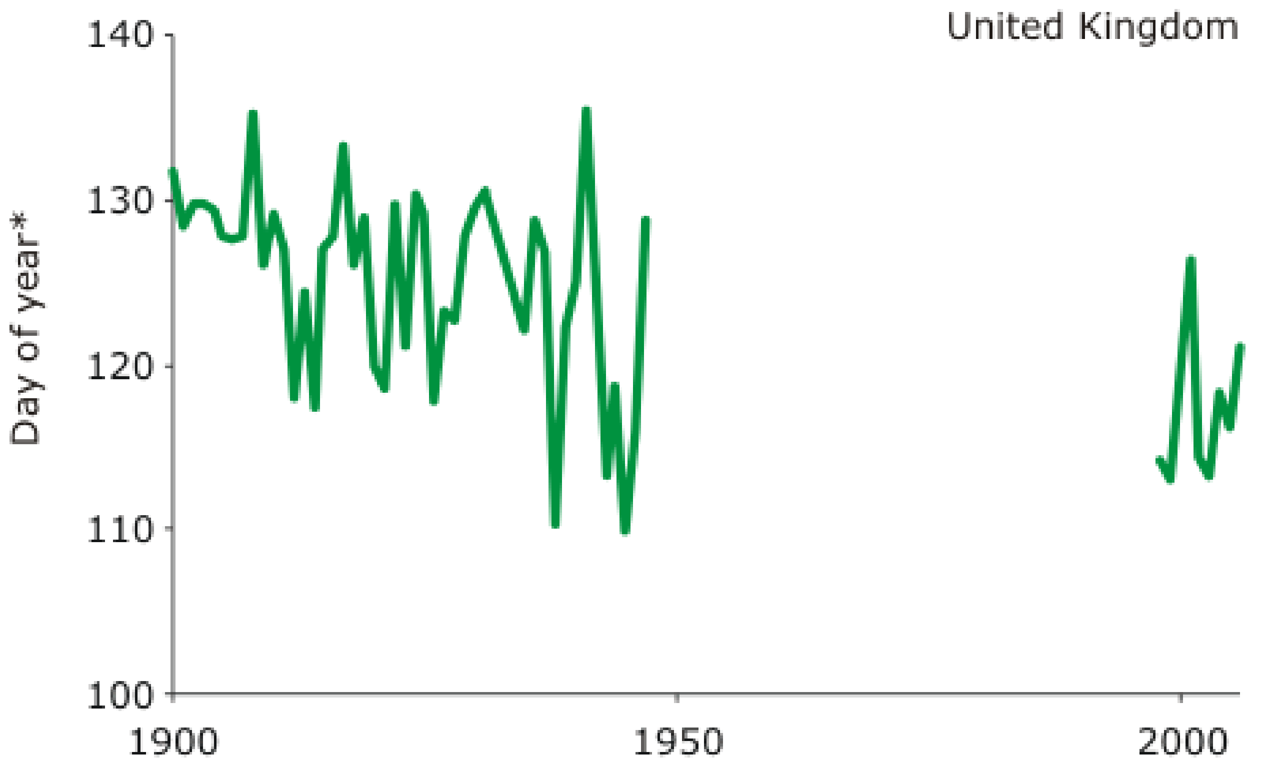
Other indicators

- Sectoral emission ‘decoupling’ indicators
- Renewable energy
- Electricity generation and emissions
- Adaptation? Bird populations
- Other biodiversity indicators e.g.
  – Butterflies
  – Plant diversity
  – Species status



Securing the future
delivering UK sustainable development strategy

Spring index - phenology



* Number of days after January 1st (e.g. day 121= May 1st)
Source: Royal Meteorological Society, UK Phenology Network

Securing the future
delivering UK sustainable development strategy

Other indicators

- Indicators for climate change objectives
  - Global CO_2 emissions to 2050
  - Areas with sustainable abstraction of water
  - Global carbon market
  - UK greenhouse gas and CO_2 emissions
  - Emissions intensity of the UK economy
  - Emissions reductions from new policies

Securing the future
delivering UK sustainable development strategy

Other indicators

- Supporting intermediate objectives
  - Fuel poverty
  - Emissions by sector
  - Energy consumption
  - Carbon intensity of energy production
  - International assistance for adaptation

Other indicators

- Sustainable Consumption & Production
  - Resource efficiency
  - Consumption impacts
  - Energy efficiency of domestic appliances
  - CO_2 emissions of Government Estate

Securing the future
delivering UK sustainable development strategy

Other indicators

- Local Government Performance
  - CO_2 emissions from local authority operations
  - CO_2 emissions from local authority community
  - Local adaptation to climate change

Securing the future
delivering UK sustainable development strategy

SD indicators as a framework?

- Do cover many climate change indicators
- But could include more on
  - Embedded emissions
  - Effects of international aviation emissions
  - Adaptation
  - Actual changes to the climate

Securing the future
delivering UK sustainable development strategy

Successful indicators

- Change the World?
- Challenge governments?
- Tell us everything?
- Drive policy?   Influence may be?
- Raise awareness?
- Get in newspapers?

Securing the future
delivering UK sustainable development strategy

Headlines

THE DAILY TELEGRAPH

It's grim up North, say life quality statistics

Securing the future
delivering UK sustainable development strategy

Headlines

THE DAILY TELEGR

It's grim
North, s
life qua
statistic

Daily Express

Great divide

<u>Head south if you want a longer life northerners told</u>

Securing the future
delivering UK sustainable development strategy

Headlines

The Guardian

Poverty and crime make it tough up north - but more birds are singing

North, s
life qua
statistic

...at divide

Head south if you want a longer life northerners told

Securing the future
delivering UK sustainable development strategy

Headlines

The Guardian

Poverty a… north - bu… …ke it tough up …g

Nor… life qu… statistics

…vide …ou …nger life northerners told

THE TIMES

Life sounds sweet in poorer North

Securing the future
delivering UK sustainable development strategy

Successful indicators

- Involve policy colleagues
- Have policy support and commitment
- Have user-friendly communication
- Are compact and concise
- Get the message across!

Securing the future
delivering UK sustainable development strategy

Now there's an idea …

www.sustainable-development.gov.uk
www.defra.gov.uk

Securing the future
delivering UK sustainable development strategy

The System of Environmental-Economic Accounting (SEEA) and its contribution to Climate Change Policies

Alessandra Alfieri
United Nations Statistics Division

Outline

- What is the SEEA?
- SEEA and emission inventories
- Policy relevance of the SEEA
  - Greenhouse gas emissions
  - Impacts
  - Mitigation
  - Adaptation
- Conclusions

Brief history

- 1992: Agenda 21called for "establishing systems for integrated environmental and economic accounting in all member States at the earliest date"
- SEEA-1993: satellite accounts
- SEEA-2003: major step forward towards harmonization however unresolved issues remain
- UN Statistical Commission therefore established the UN Committee of Experts in Environmental-Economic Accounting (UNCEEA) in 2005
- SEEA to become an international statistical standard by 2011
- UNCEEA identified Climate Change (CC) as one of the overarching themes for the SEEA revision

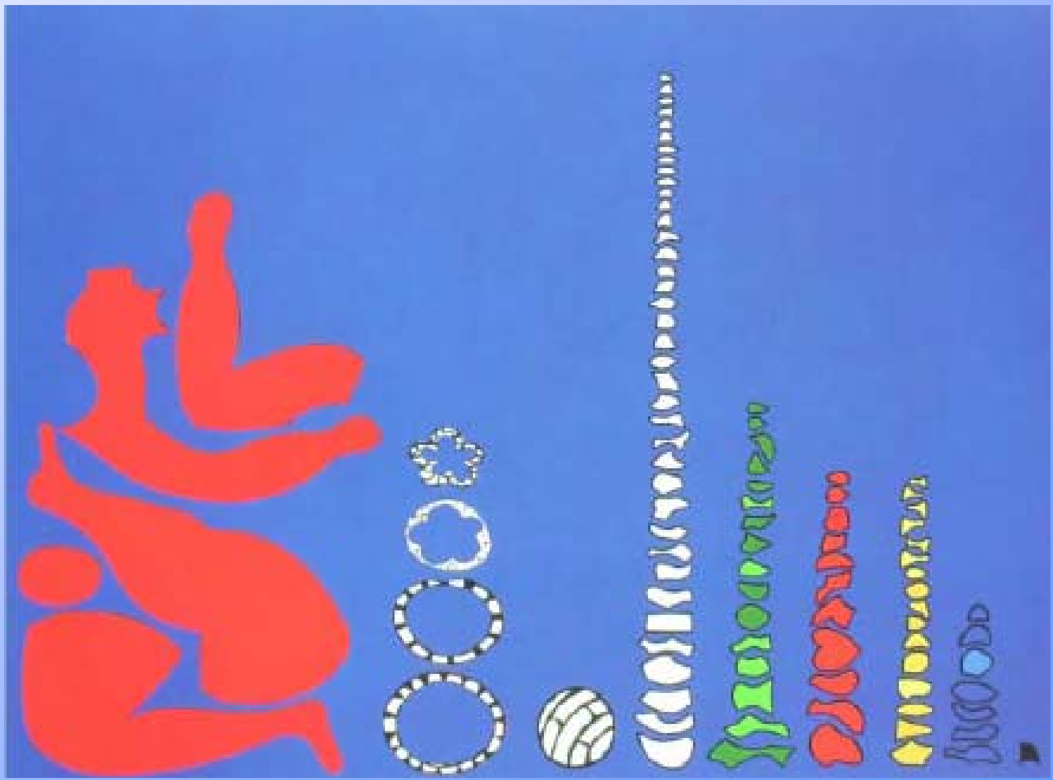
What is SEEA?

- Integration framework that measures interaction between economy and environment
- Consistent with System of National Accounts (SNA)
  - Common classifications (ISIC, CPC)
  - Common concepts (e.g. residence)
- Expands the analytical capacity of National Accounts
  - Enlarged asset boundary (e.g. ecosystems)
  - Includes complementary elements (e.g. physical information, etc.)
  - Elaborates aspects that are not explicitly identified in the accounts (e.g. ETS)
- Used to identify more sustainable paths of development (indicators and modeling)

Environmental-Economic Accounting vs Environment Statistics

Environment statistics:

- Often developed to answer one particular question or problem
- Difficult to figure out if all information is included
- Not always easy to see the whole picture, or how it relates to other things



Source: Julie Hass

Environmental-Economic Accounting vs Environment Statistics

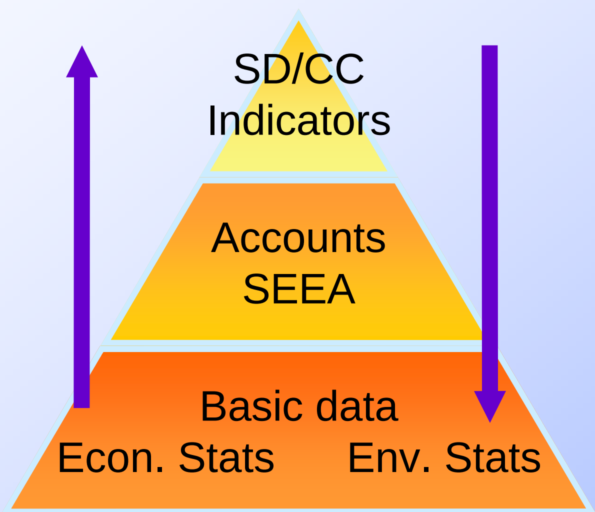
Environmental accounts:

- Help to make sense of the larger picture
- Help to identify pieces that are missing
- Can make connections to other statistics - especially economic statistics

Source: Julie Hass

Why an accounting approach?

policy
relevance



interlinkages -
underlying causes

Provides **added value**:

- Implicitly defines ownership and hence responsibility for environmental impacts
- Improves statistical quality by guaranteeing consistency (checks and balances)
- Provides policy-makers with coherent time series of data, indicators and descriptive statistics for scenario modeling

SEEA modules

- **Asset accounts**: record stocks and changes in stocks (flows) of natural resources such as land, forest, water and minerals
- **Physical and hybrid flow accounts**: provide a systematic physical description of production and consumption processes, including their natural resource inputs, product throughputs and outputs i.e. wastes
- **Monetary accounts**: separately identify environmentally-related transactions presented in the existing SNA flow accounts in order to make them more explicit for analysis
- **Environmentally-adjusted aggregates:** combine modules of SEEA to form a full-sequence of accounts from which aggregates such as an eaGDP (‘Green GDP’), or Net Saving (‘Genuine Saving’), can be derived. These adjustments could include depletion, defensive expenditures and degradation.

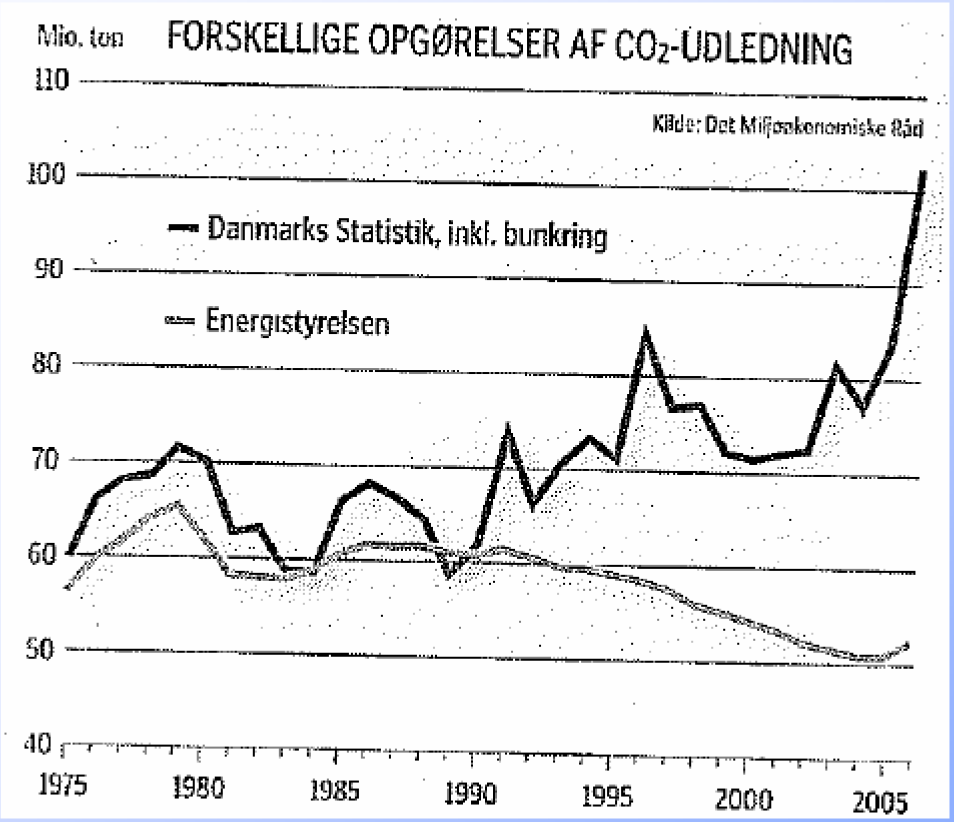
SEEA and UNFCCC reporting

SEEA Emission Accounts	UNFCCC reporting
Residence	Territory
Activity (ISIC)	Process (IPCC source classification)

- Different policy concerns
- How to harmonize them?
  - *Need to better understand differences (bridge tables)*
  - *Need to harmonize and further develop common classifications so as to use the same data twice*
  - *Need to improve coordination*

Example: Danish newspaper

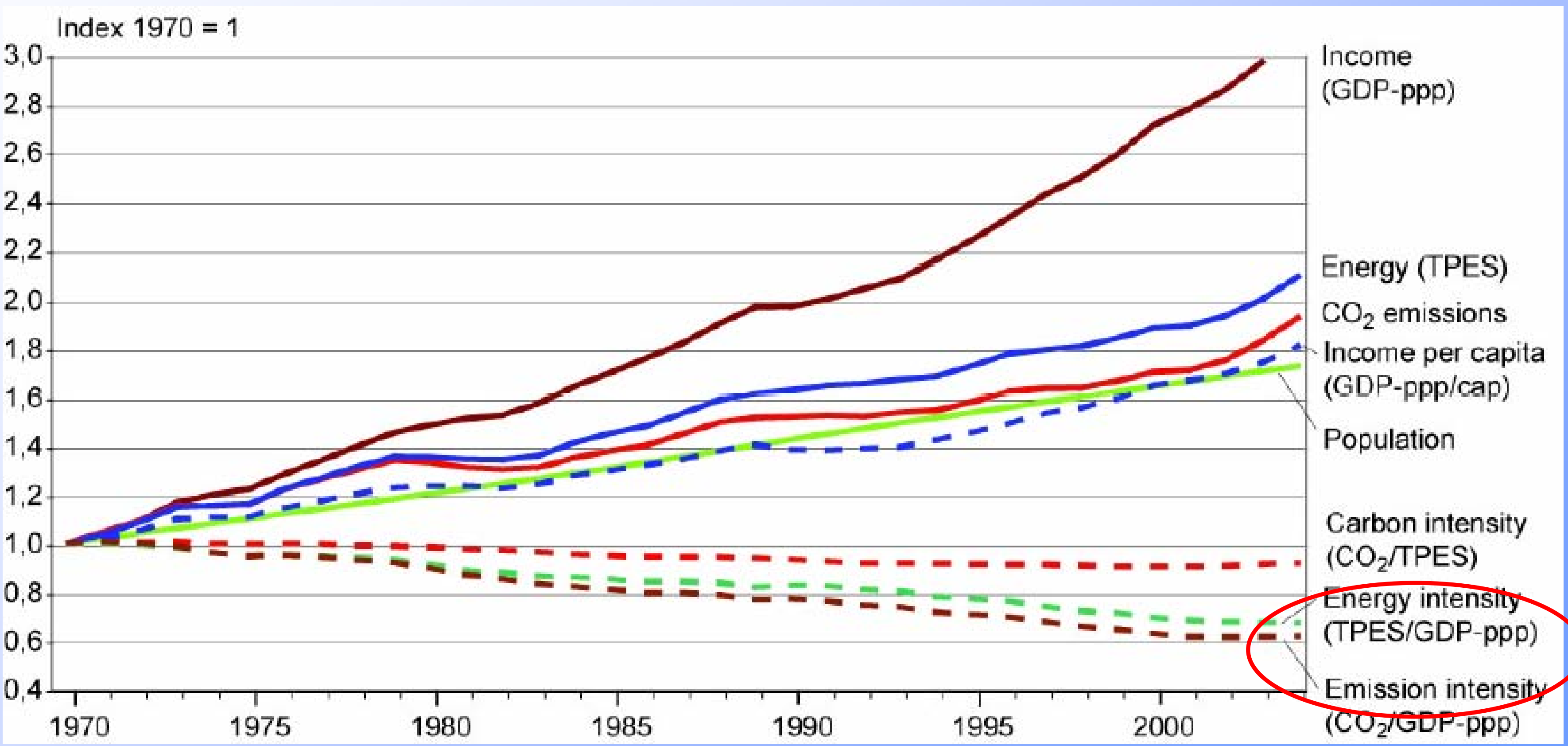
"Is decoupling a myth?"



Source: Dagbladet Information

Conceptual differences matter and are highly policy relevant for Denmark

Intensities of energy use and CO2 emissions, 1970-2004



Source: IPCC AR4 - WG 3 p.

Policy relevance – mitigation

Value added of SEEA:

- GHG/aerosol emissions by industry
- Energy/emission intensity by industry (consistently)

Integration with economic statistics allows to :

- Asses the effectiveness of carbon taxes on energy intensity of industries
- Analyze the effectiveness of ETS
- Assess expenditures on technology and their financing

Applications of SEEA allows to:

- Assess the effects of ‘carbon leakage’ through decomposition analysis of driving forces of emissions, and
- Calculation of indirect emissions

Policy relevance – impacts

Land and ecosystem accounts (LEAC) ➡

- Track changes in land cover/use over time allow to assess deforestation, desertification etc.
- Same approach as IPCC estimates for forestry sector

Water accounts

Link the economy with the hydrological system thus allowing for measuring:

- Water availability
- Water efficiency by economic activity, water reuse
- Hydraulic infrastructure in place (physical and monetary)
- Fees, taxes, permits
- Financing

LEAC and Water Accounts can be compiled at any level of disaggregation

➢ *Need to develop and harmonize land use classifications*

Policy relevance – adaptation

Value added of SEEA:

Integration with economic statistics provides information on:

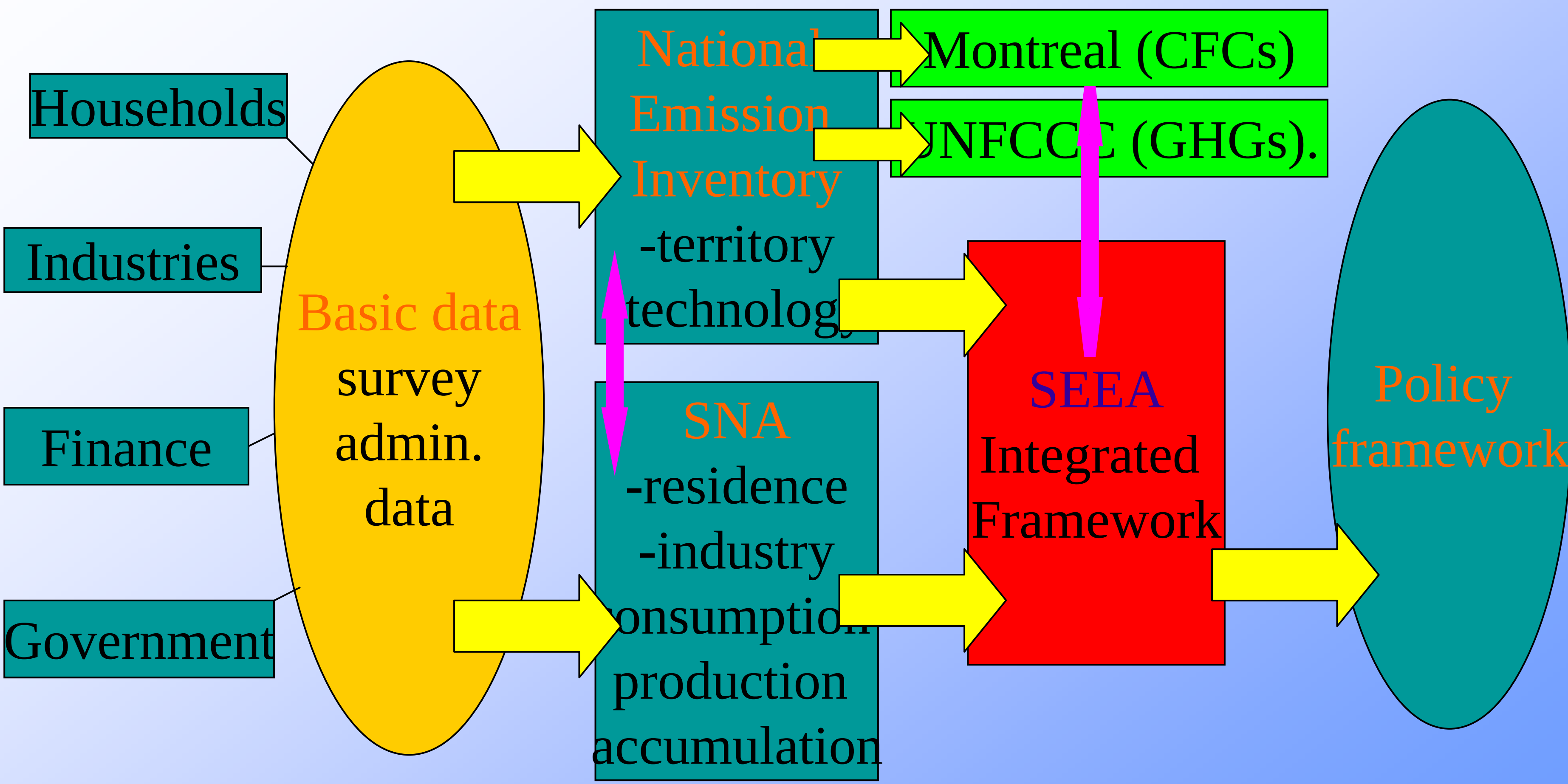
- Technologies and their financing (within country + between countries)
- Capital investments (stocks of fixed assets e.g. dykes, levees) and their depreciation

Functional classification in SEEA allows:

- Assess impacts and effectiveness of adaptation strategies
  - Information from the accounts input in CGE models to assess trade-offs between mitigation and adaptation strategies

➢ *Need for adapting functional classification of*

Statistical coordination



Need to review statistical coordination in data collection and compilation

Conclusions

- A lot of information is available but it needs to be organized
- SEEA provides the integration framework of basic statistics for the derivation of climate change indicators
- Allows for identification of gaps and overlaps of data and leads to a more efficient production of information
- Statistics collected once should be used for multiple purposes (UNFCCC reporting, SEEA, etc.) and will
  - Reduction in response burden
  - Improvement in data quality
  - Lower costs of data production
- SEEA brings value added to CC policies
- SEEA can be compiled with limited additional resources but provides large value added
- SEEA will soon be standard

What next?

- Coordination, Coordination, Coordination:

⇒ Between statisticians and scientists

⇒ Between statisticians and policy makers

⇒ Within the statistical community

World Data Center for Human Interactions in the Environment

Conference on Climate Change and Official Statistics
Oslo, Norway, 14-16 April 2008

The Role of Spatial Data Infrastructure in Integrating Climate Change Information with a Focus on Monitoring Observed Climate Impacts

CIESIN

Columbia University

Introduction

World Data Center for Human Interactions in the Environment

- Objective: to document the impacts of climate change.
  - How do we do this?

- One way: the methodology of the IPCC's Fourth Assessment (Rosenzweig et al., Chapter 1, Working Group 2)
  - illustration of how integrated spatial data infrastructures are essential for identifying such impacts systematically

The Underlying Question

World Data Center for Human Interactions in the Environment

- Which of the observed changes across systems and geographic regions are actually due to *anthropogenic climate forcing*, and which can be attributed to *natural variability over time*, or other *non-climate drivers of change* such as geological processes, land use change, land-cover modification, invasive species, pollution?

Rosenzweig et al.

World Data Center for Human Interactions in the Environment

- Observed changes and their effects related to the cryosphere, hydrology and water resources, coastal processes and zones, freshwater and marine biological systems, terrestrial biological systems, agriculture and forestry, human health, and disasters and hazards related to regional warming.
  - Describes regional climate and non climate driving forces for the systems,
  - Assesses the evidence regarding observed changes in key processes, and
  - Highlights issues regarding the absence of observed changes and conflicting evidence.

Methods: observed versus predicted

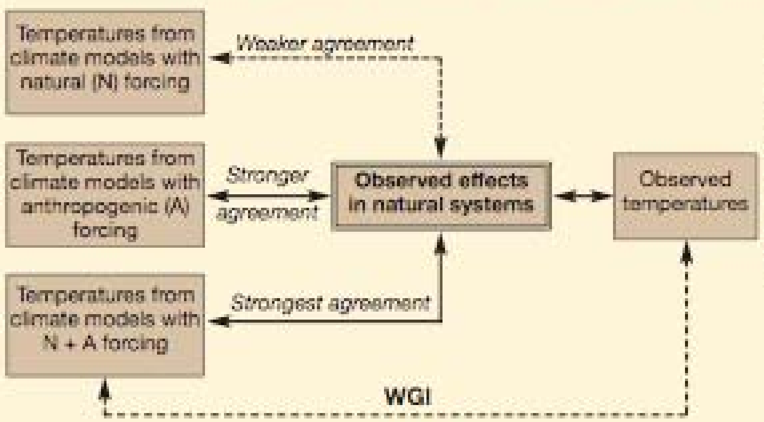
World Data Center for Human Interactions in the Environment

- Where long data series exist, the detection of trends or changes in system properties that are beyond natural variability has most commonly been made with regression, correlation and time-series analyses.
- When data exist from two (or more) discontinuous time periods, two-sample tests have frequently been employed.
- Testing is also done for abrupt changes and discontinuities in a data series.
- Regression and correlation methods are frequently used in the detection of a relationship of the observed trend with climate variables.
- Methods also involve studies of process-level understanding of the observed change in relation to a given regional climate change, and the examination of alternative explanations of the observed change, such as land use change.
- The analysis sometimes involves comparisons of observations to climate-driven model simulations.

Linking Cause to Effect

World Data Center for Human Interactions in the Environment

Box SM.1. Linking the causes of climate change to observed effects on physical and biological systems. In chapter synthesis assessment in Section 1.4



The figure to the left demonstrates the linkages between observed temperatures, observed effects on natural systems, and temperatures from climate model simulations with natural, anthropogenic, and combined natural and anthropogenic forcings. Two ways in which these linkages are utilised in detection and attribution studies of observed effects are described below.

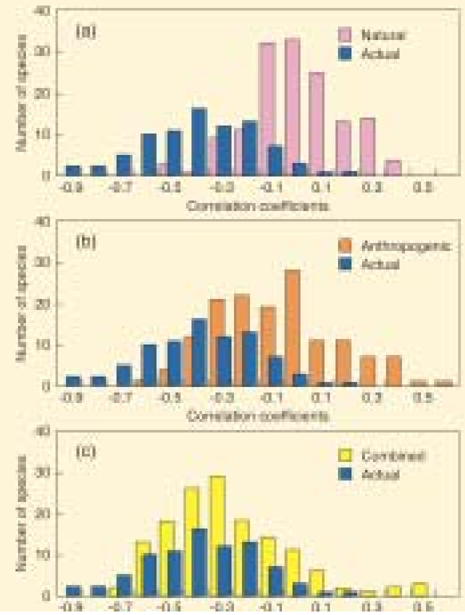
Climate Models

1. Using climate models

The study of causal connection by separation of natural and anthropogenic forcing factors compares observed temporal changes in animals and plants with changes over the same time periods in observed temperatures as well as modelled temperatures using (i) only natural climate forcing; (ii) only anthropogenic climate forcing; and (iii) both forcings combined.

The panel to the right shows the results from a study employing this methodology[1]. The locations for the modelled temperatures were individual grid boxes corresponding to given animal and plant study sites and time periods.

The agreement (in overlap and shape) between the observed (blue bars) and modelled plots is weakest with natural forcings, stronger with anthropogenic forcings, and strongest with combined forcings. Thus, observed changes in animals and plants are likely responding to both natural and anthropogenic climate forcings, providing a direct cause-and-effect linkage [F1.7, 1.4.2.2].



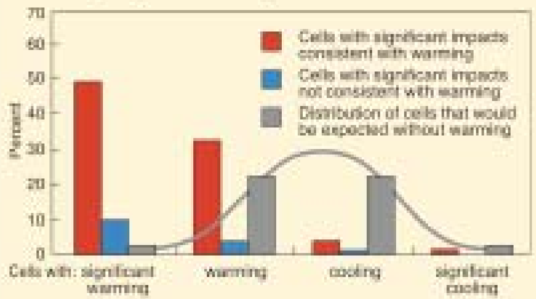
Study of causal connection by separation of natural and anthropogenic forcing factors compares observed temporal changes in animals and plants with changes over the same time periods in observed temperatures as well as modeled temperatures using:

- Only natural climate forcing
- Only anthropogenic climate forcing
- Both combined

Using Spatial Analysis

Correlation coefficients

2. Using spatial analysis



The study of causal connection by spatial analysis follows these stages: (i) it identifies 5° × 5° latitude/longitude cells across the globe which exhibit significant warming, warming, cooling, and significant cooling; (ii) it identifies 5° × 5° cells of significant observed changes in natural systems that are consistent with warming and that are not consistent with warming; and (iii) it statistically determines the degree of spatial agreement between the two sets of cells. In this assessment, the conclusion is that the spatial agreement is significant at the 1% level and is very unlikely to be solely due to natural variability of climate or of the natural systems.

Taken together with evidence of significant anthropogenic warming over the past 50 years averaged over each continent except Antarctica [WGI AR4[2] SPM], this shows a discernible human influence on changes in many natural systems [1.4.2.3].

---

[1] Plotted are the frequencies of the correlation coefficients (associations) between the timing of changes in traits (e.g., earlier egg-laying) of 145 species and modelled (HadCM3) spring temperatures for the grid-boxes in which each species was examined. (Continues at bottom of previous page).

[2] IPCC, 2007: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, Eds., Cambridge University Press, Cambridge, 996 pp.

Gridded Surface Temperatures

World Data Center for Human Interactions in the Environment

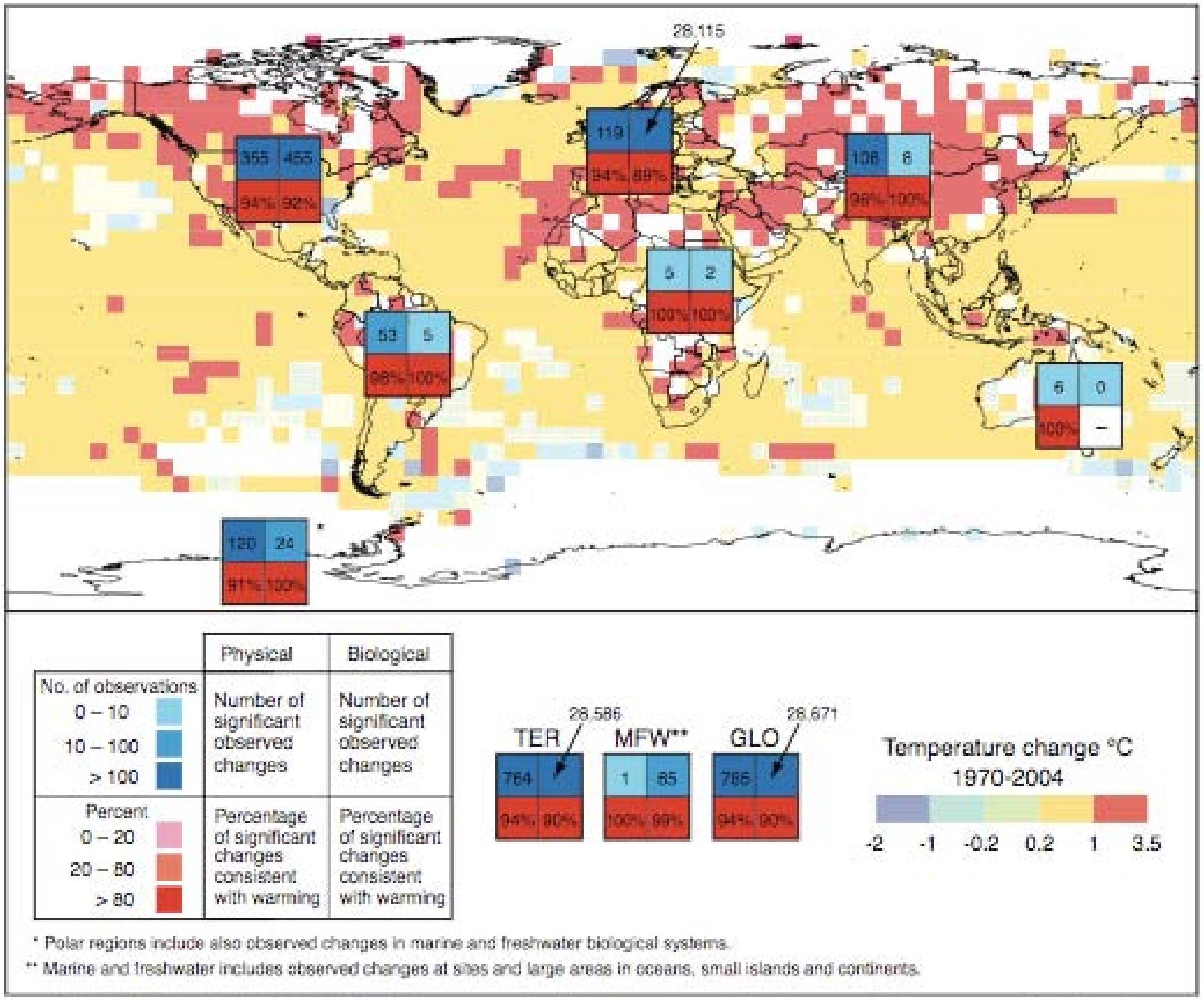


Figure SM-1.4. *Changes in physical and biological systems and surface temperature used in chapter synthesis assessment in Section 1.4. Background shading, and the key to the bottom right, show changes in gridded surface temperatures over the period 1970-2004. The boxes, and the key to bottom left, show the continental-scale changes in physical (left-hand column) and biological (right-hand column) systems calculated from individual series with at least 20 years data in the 1970-2004 period; the top row shows the number of observed series matching the length criterion that show a significant trend and the bottom row shows the percentage of these in which the trend is consistent with warming. At the global scale TER = Terrestrial; MFW = Marine and Freshwater, and GLO = Global.*

Another example: Differences in the mean onset of spring in Europe

World Data Center for Human Interactions in the Environment

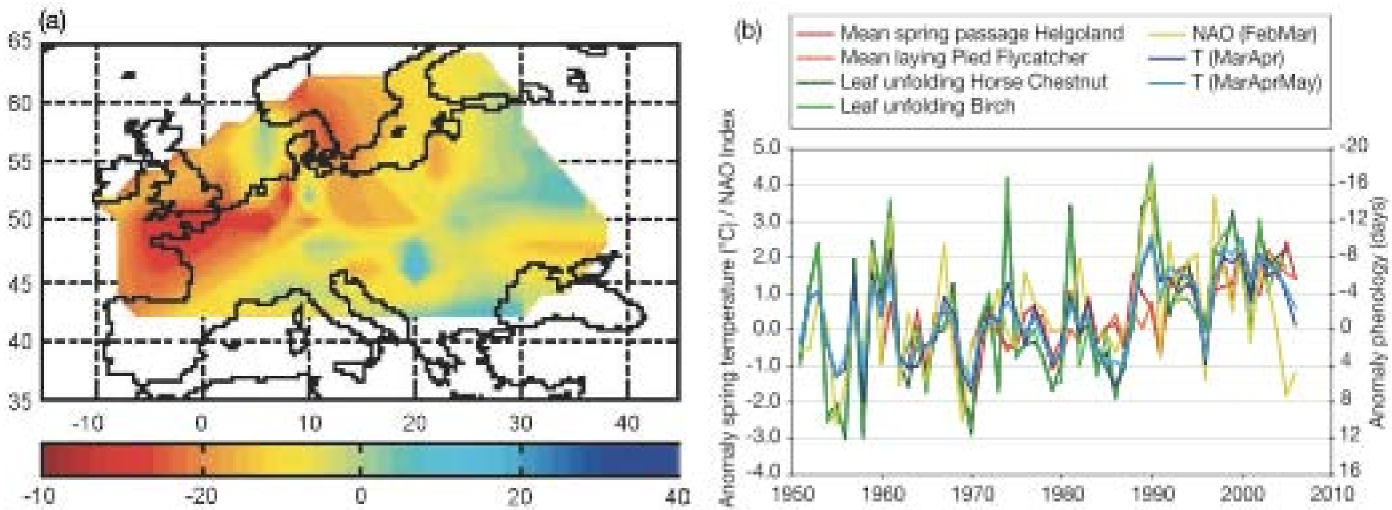


Figure 1.4. *(a) Differences between the mean onset of spring (days) in Europe for the 10 years with the highest (1990, 1882, 1928, 1903, 1993, 1910, 1880, 1997, 1989, 1992) and the lowest (1969, 1936, 1900, 1996, 1960, 1932, 1886, 1924, 1941, 1895) NAO winter and spring index (November to March) drawn from the period 1879 to 1998. After Menzel et al. (2005b). (b) Anomalies of different phenological phases in Germany (mean spring passage of birds at Helgoland, North Sea; mean egg-laying of pied flycatcher in Northern Germany; national mean onset of leaf unfolding of common horse-chestnut (Aesculus hippocastanum) and silver birch (Betula pendula) (negative = earlier)), anomalies of mean spring air temperature T (HadCRUT3v) and North Atlantic Oscillation index (NAO) (http://www.cru.uea.ac.uk/cru/data/). Updated after Walther et al. (2002).*

101

Linking Changes in Air Temperature to Physical and Biological Systems

World Data Center for Human Interactions in the Environment

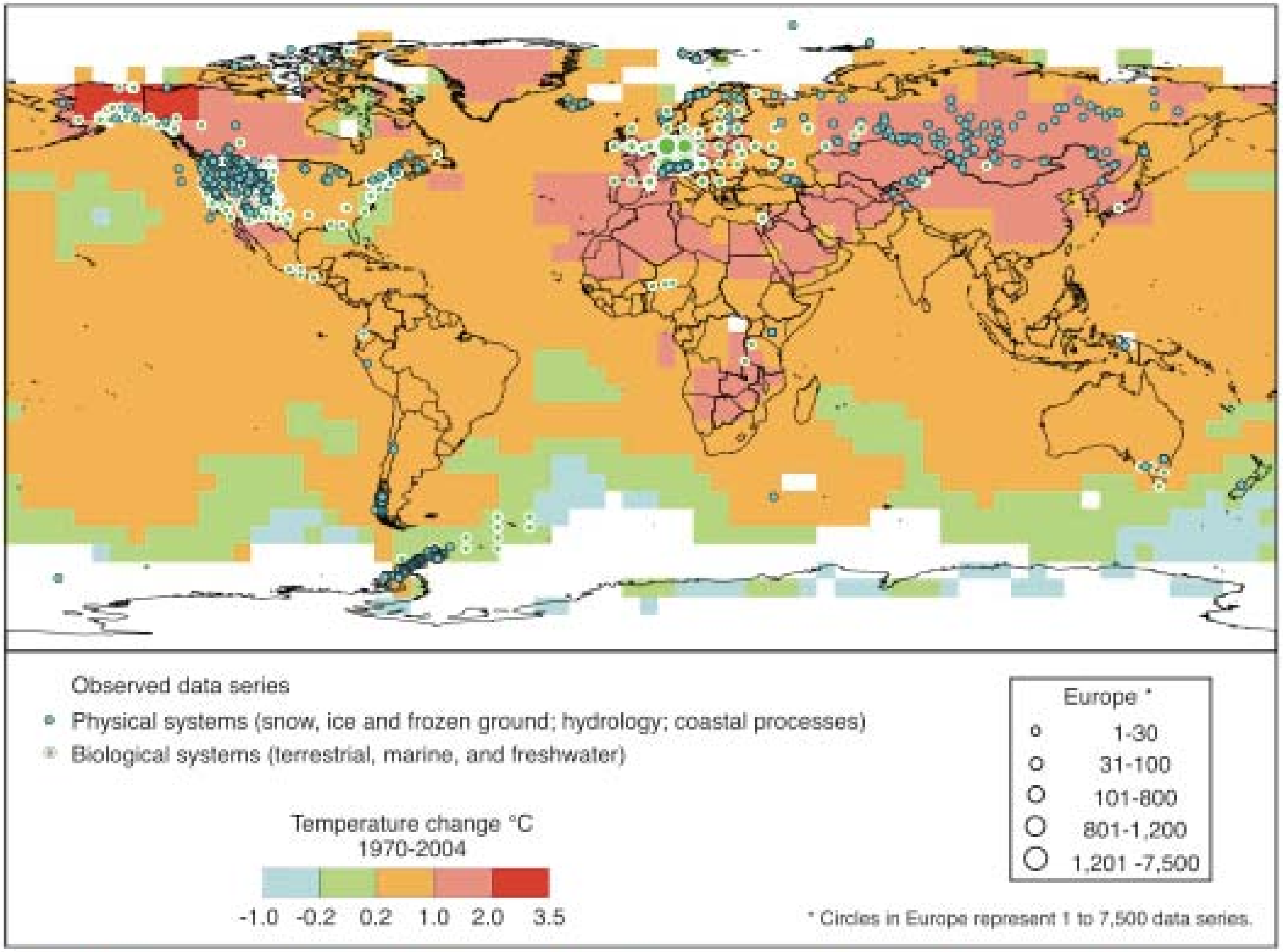


Figure 1.8. *Locations of significant changes in observations of physical systems (snow, ice and frozen ground; hydrology; coastal processes) and biological systems (terrestrial, marine and freshwater biological systems), are shown together with surface air temperature changes over the period 1970 to 2004 (from the GHCN-ERSST datatset). The data series met the following criteria: (1) ending in 1990 or later; (2) spanning a period of at least 20 years; (3) showing a significant change in either direction, as assessed by individual studies. White areas do not contain sufficient observational climate data to estimate a temperature trend.*

Data: Lack of Geographic Balance

- Dots in the previous slides represent about 75 studies, which have >29,000 data series (of which ~27,800 are from European phenological studies of flora and fauna)

Chapter conclusions

World Data Center for Human Interactions in the Environment

- There is a notable lack of geographical balance in the data and literature on observed changes in natural and managed systems, with a marked scarcity from developing countries.

- Possible reasons for this imbalance are:
  - lack of access by IPCC authors,
  - lack of data, research and published studies,
  - lack of knowledge of system sensitivity,
  - differing system responses to climate variables,
  - lag effects in responses,
  - resilience in systems, and
  - the presence of adaptation.

- Needs:
  - to improve the observation networks, and
  - to enhance research capability on changes in physical, biological and socio-economic systems, particularly in regions with sparse data.

Key questions

- How many countries are equipped to document climate change in this way?

- What does it take to get there?

CIESIN
Columbia University

Building a Spatial Data Infrastructure (SDI)

WDC
World Data Center for Human Interactions in the Environment

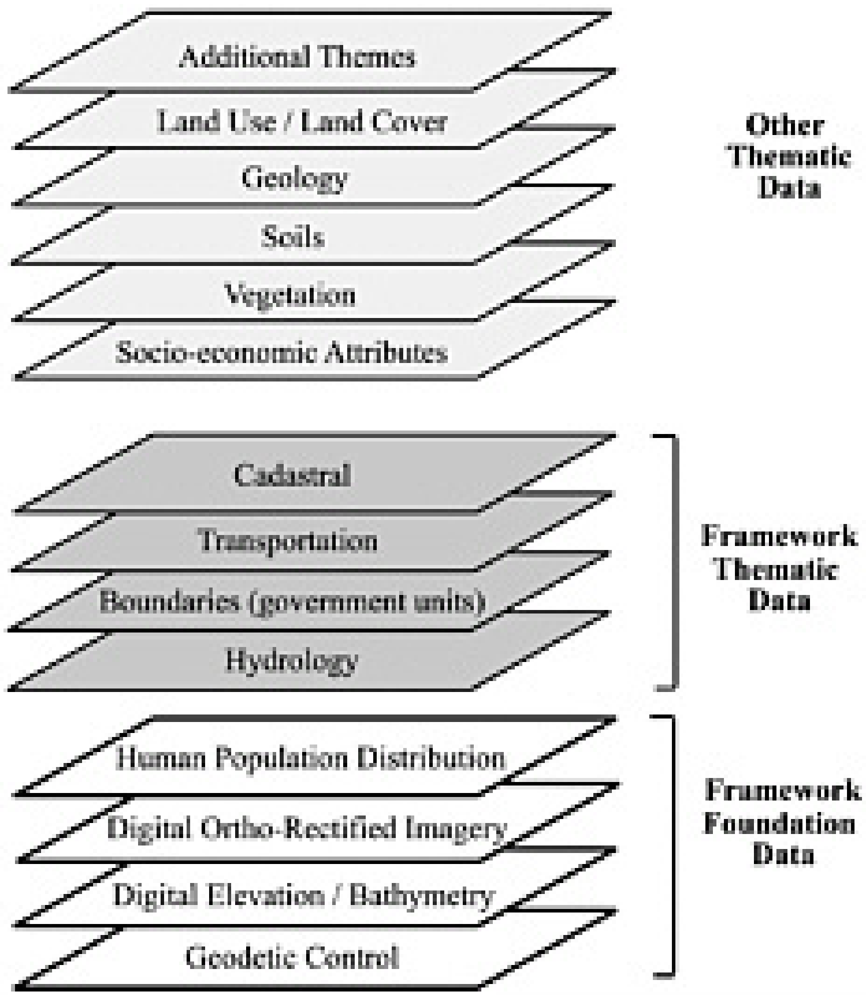
"An SDI comprises standards, framework foundation data, framework thematic and other geographic data, metadata, clearinghouses and partnerships."

For example: Linking of weather records, public health data, biological surveillance

Spatial Data Infrastructure Data Layers

World Data Center for Human Interactions in the Environment

- Earth and social scientists use different units of analysis and have different ways of aggregating data
  – e.g., pixels vs. individuals, physical features vs. households, physiographic vs. administrative regions, grids vs. countries
- Linking such data requires conversion of data between geographies
  – e.g., grids to administrative units or vice versa



CIESIN Columbia University

US Example

World Data Center for Human Interactions in the Environment

Federal Geographic Data Committee (FGDC) created in 1990 to develop a strategy for an NSDI (national spatial data infrastructure

Goal: “Current and accurate geospatial data that is readily available (locally, nationally and globally)”

US NSDI example

Intent is to:

1. Reduce duplication of effort by government agencies in data collection
2. Improve quality and reduce costs related to geographic data
3. Make geographic data more accessible to the public
4. Increase the benefits of using available data
5. Establish key partnerships with states, counties, cities, tribal nations, academic, and the private sector.

From US FGDC

SDI Framework Foundation Layers

World Data Center for Human Interactions in the Environment

- **Geodetic Control (GPS) –** common reference system for establishing the coordinate position (lat, long, elevation) of geographic data throughout an SDI
- **Digital Elevation / Bathymetry (GTOPO30, SRTM) –** height above or below a certain point (usually sea level)
- **Digital Ortho-Rectified Imagery (eg Landsat)–** specially processed image prepared from an aerial photograph or remotely sensed image that has the metric qualities of a traditional line map with the detail of an aerial image
- **Human Population Distribution (GPW, Landscan2000)**

Global datasets, national data can be extracted, or alternate national-level sources used

SDI Framework Thematic Layers

World Data Center for Human Interactions in the Environment

- **Cadastral** – Geographic extent of past, current, and future rights and interests of private and commercial property
- **Transportation** – Roads, railways, waterways, and pipelines
- **Boundaries** (government units)
- **Hydrology** – 3 categories of hydrologic features:
  - 1. Surface water: oceans, lakes, etc
  - 2. Linear features: rivers, canals, shorelines
  - 3. Point features: wells

CIESIN Columbia University

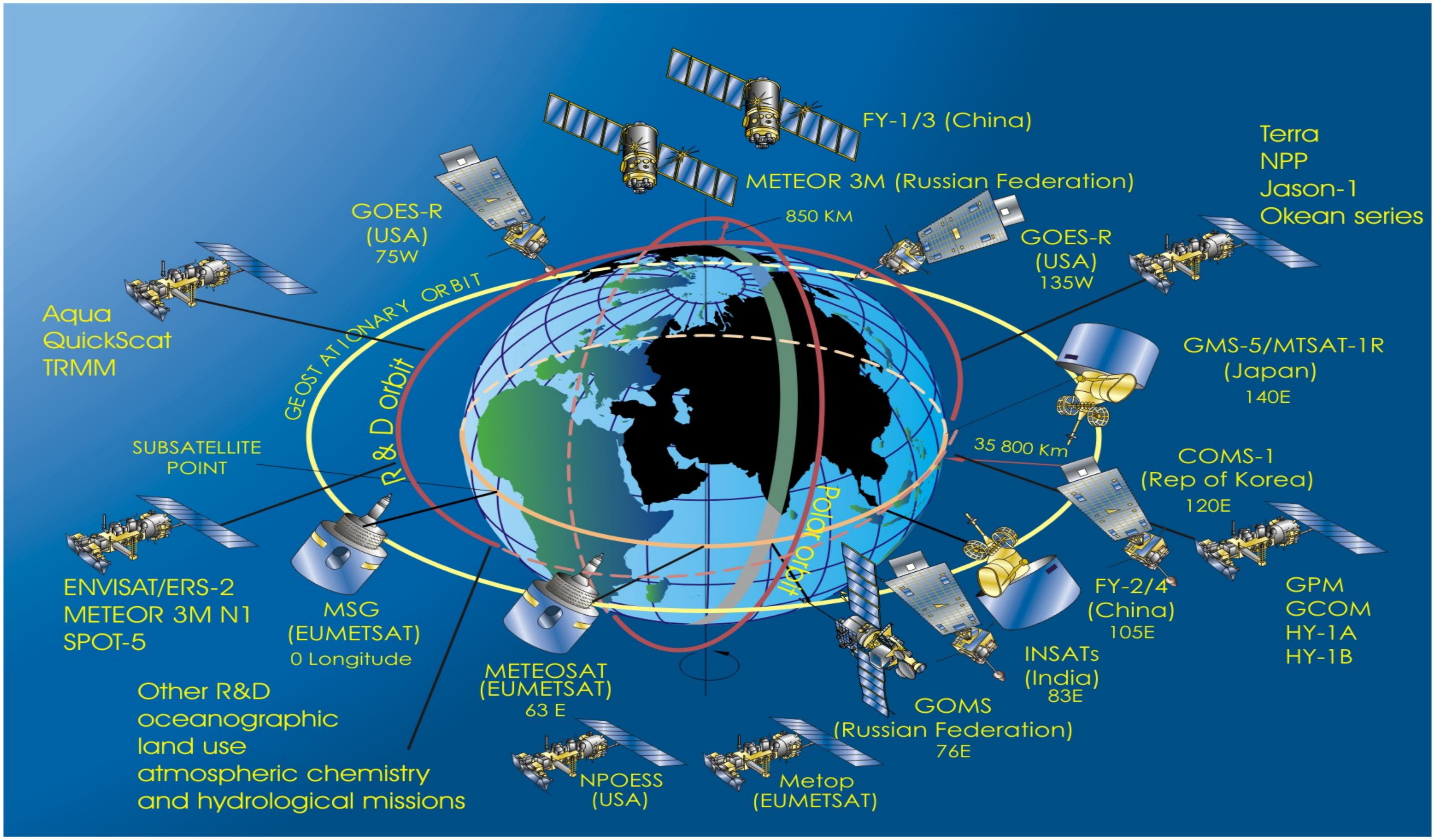
SDI: Other Thematic Layers

World Data Center for Human Interactions in the Environment

- Socio-economic attributes
- Vegetation
- Soils
- Geology
- Land use/Land cover
- Additional themes

Availability of Remote Sensing Data

World Data Center for Human Interactions in the Environment



CIESIN Columbia University

GEO and GEOSS

World Data Center for Human Interactions in the Environment

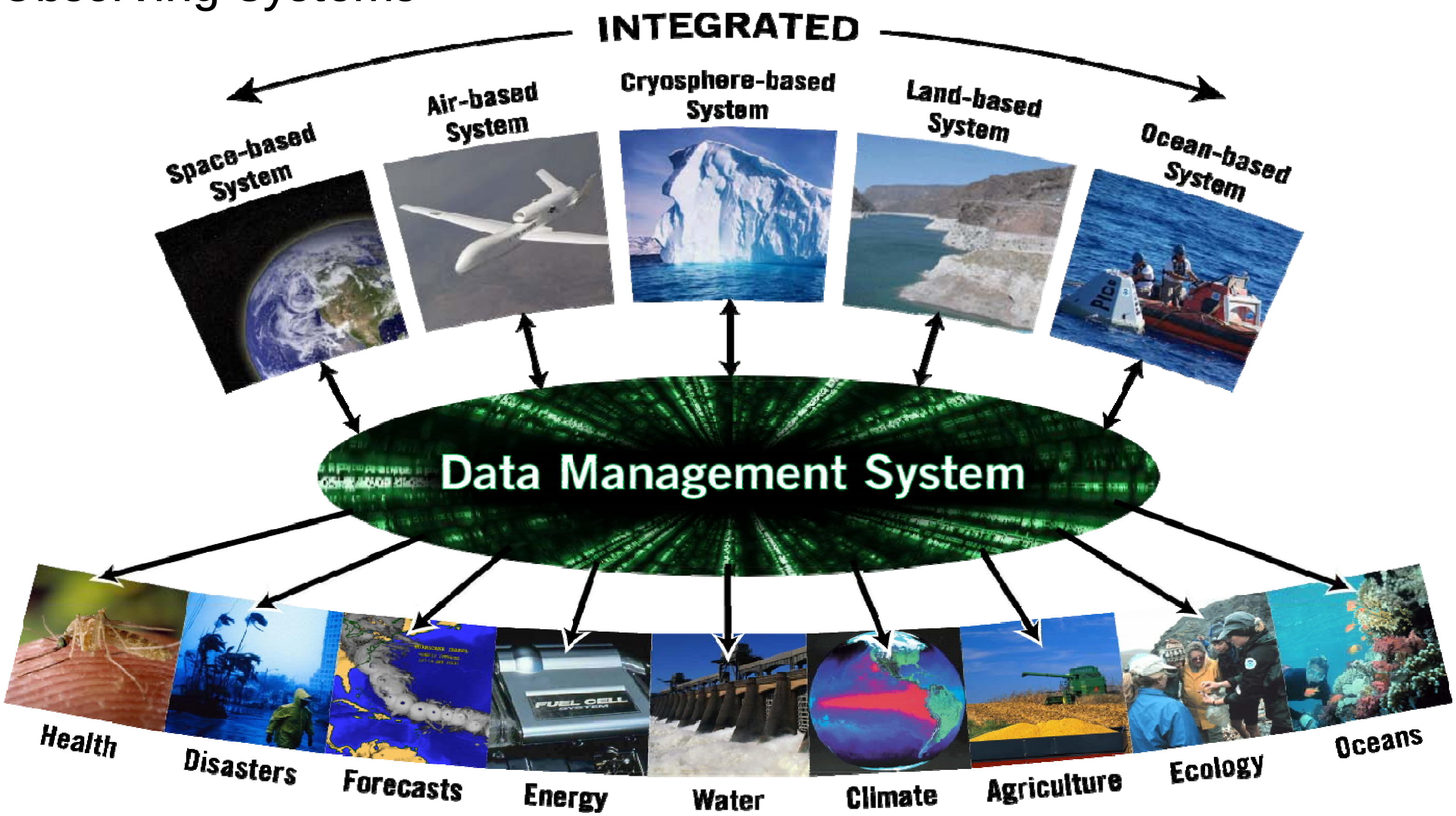
- Group on Earth Observations (GEO) is coordinating efforts to build GEOSS – Global Earth Observation System of Systems:

"An emerging public infrastructure interconnecting a diverse and growing array of systems for monitoring and forecasting changes in the global environment"

Global Earth Observing System of Systems (GEOSS)

World Data Center for Human Interactions in the Environment

A Global, Coordinated, Comprehensive and Sustained System of Earth Observing Systems



Addresses the need for timely, quality, long-term, global information as a basis for sound decision making.

To detect and assess climate change, one needs to have a stable and reliable reference framework to underpin:

This framework underpins:

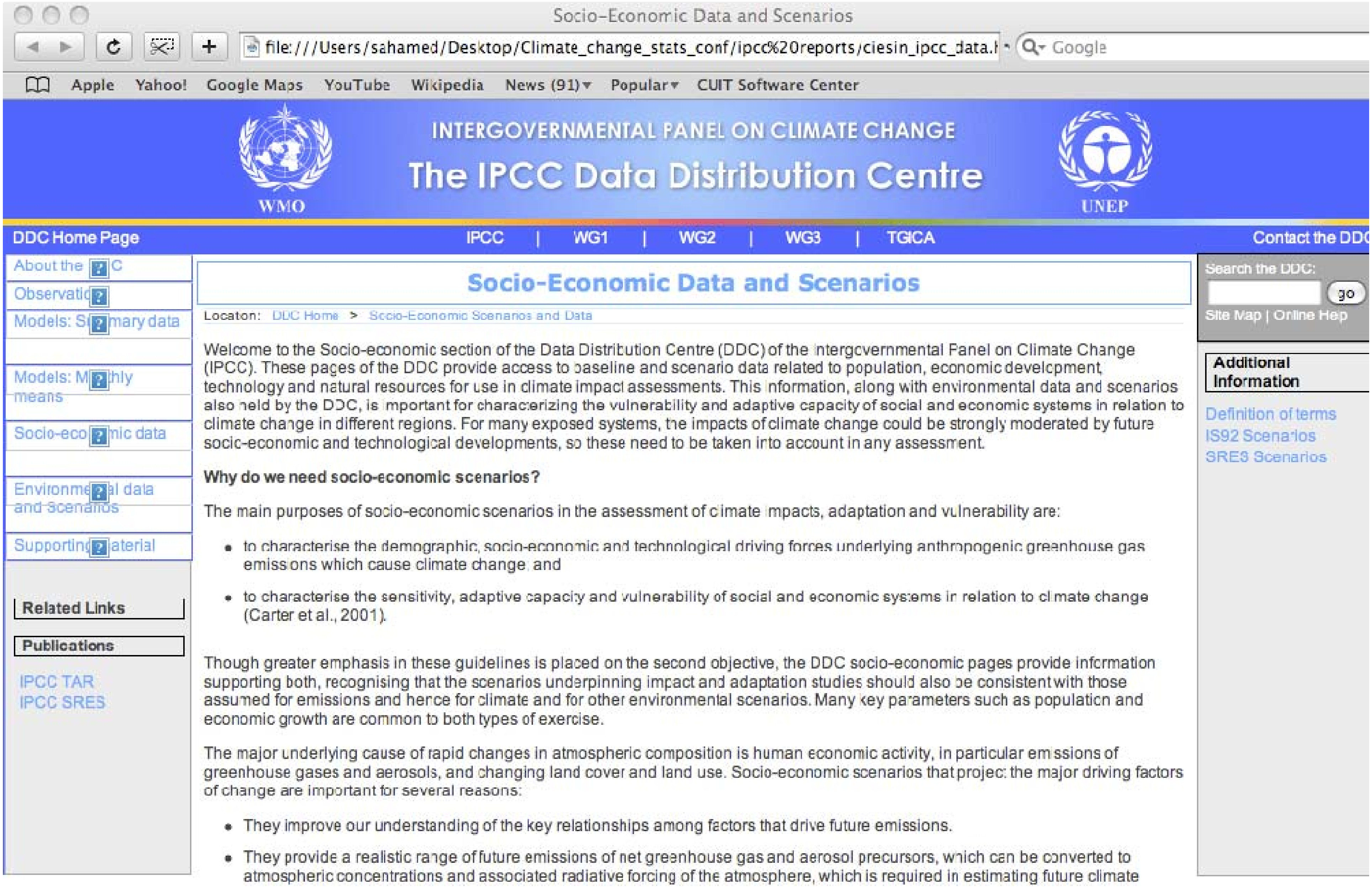
1) preparation of historical or baseline data on climatic, ecological, and socioeconomic conditions

2) development of consistent, long-term records for key parameters in which errors associated with calibration, georeferencing, instrument changes, etc. have been minimized and characterized

3) integration of different types of data to enable understanding of interactions and feedbacks between climatological, ecological, and human systems.

Conclusion

Unfortunately, SDI development even in developed countries is still fairly experimental, and figuring out how to establish an SDI capable of supporting the monitoring, detection, and prediction of climate change on decadal time scales remains a big challenge.



For IPCC socio-economic data and scenarios:

http://sedac.ciesin.columbia.edu/ddc/

Statistiska centralbyrån Statistics Sweden

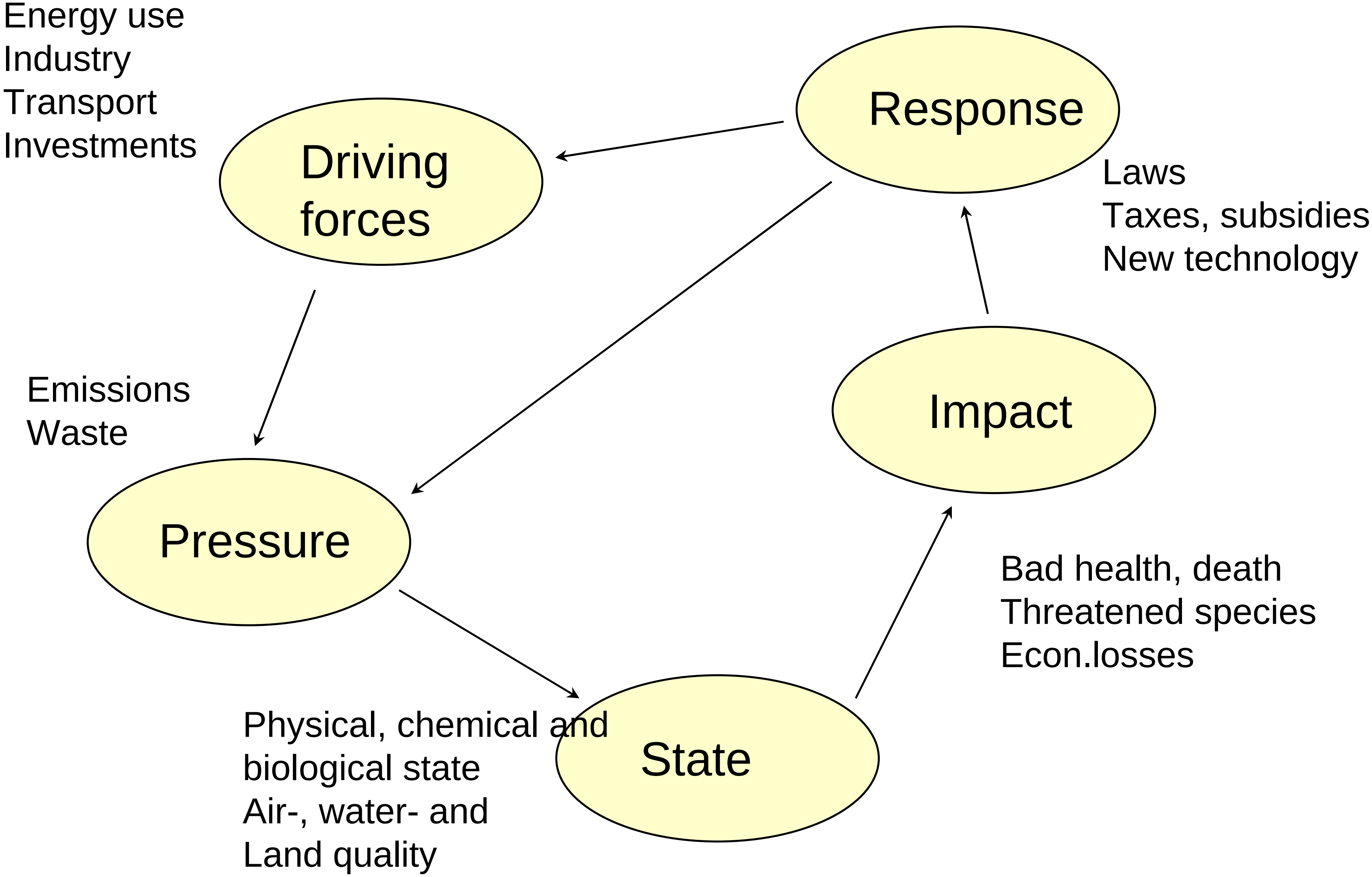
The climate challenge - implications for sectoral statistics

Viveka Palm and Nancy Steinbach, Statistics Sweden.
Contact: viveka.palm@scb.se

In order to make good targets, policy and follow-up in the climate change area, there is a need for well integrated official statistics.

Here we outline some of the experiences of the integration of sectoral statistics in Sweden, and what challenges lies ahead.

DPSIR-model. Data needs



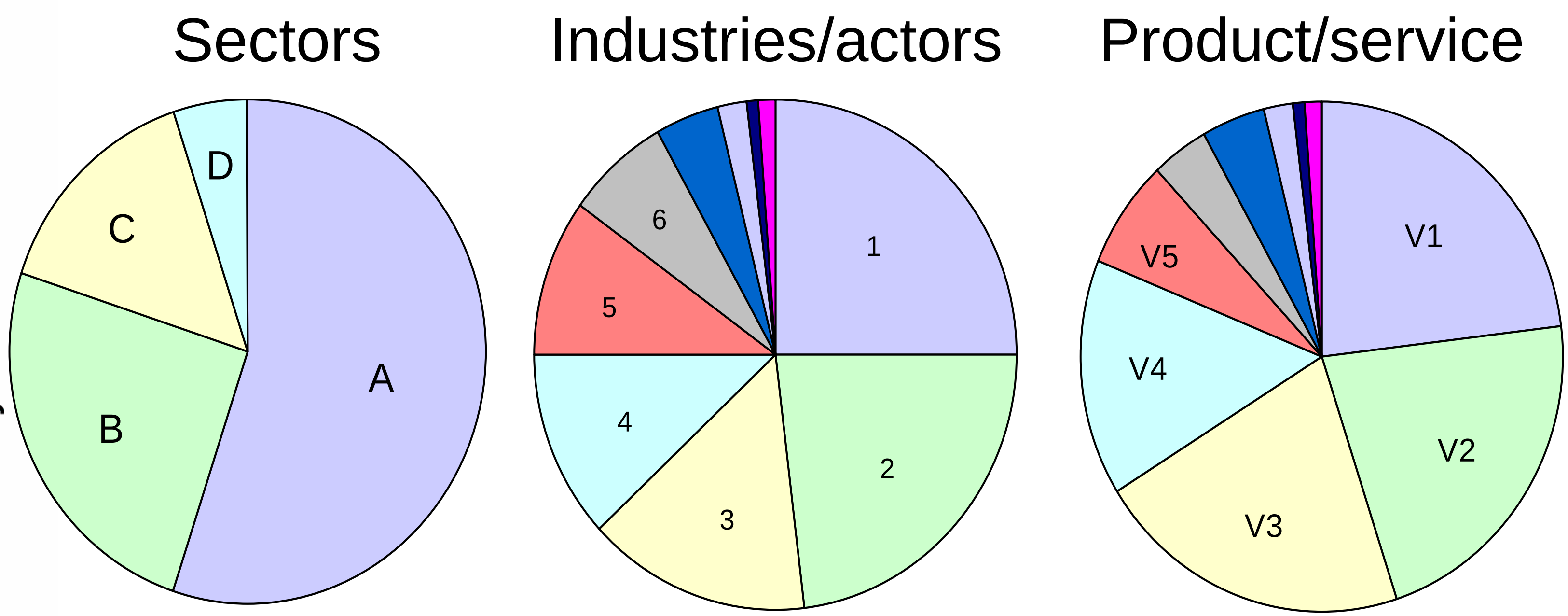
Sectoral statistics

Statistiska centralbyrån Statistics Sweden

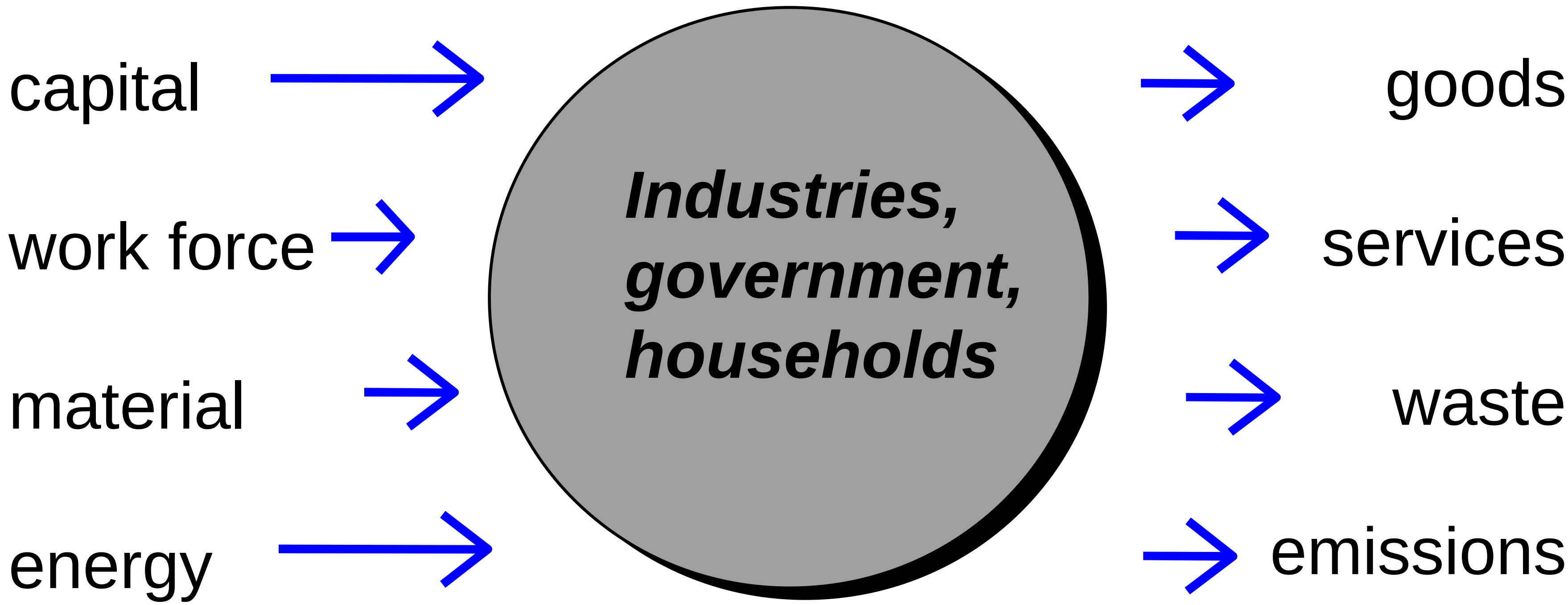
1. National accounts: taxes and subsidies
2. Environmental statistics: emissions, resources, land use
3. Energy statistics
4. Transport statistics
5. Agricultural statistics
6. Trade statistics
7. Household statistics

8. Company statistics, the business register
9. Government statistics: budget
10. Environmental protection expenditure and investments
11. Social statistics (employment, health, income)

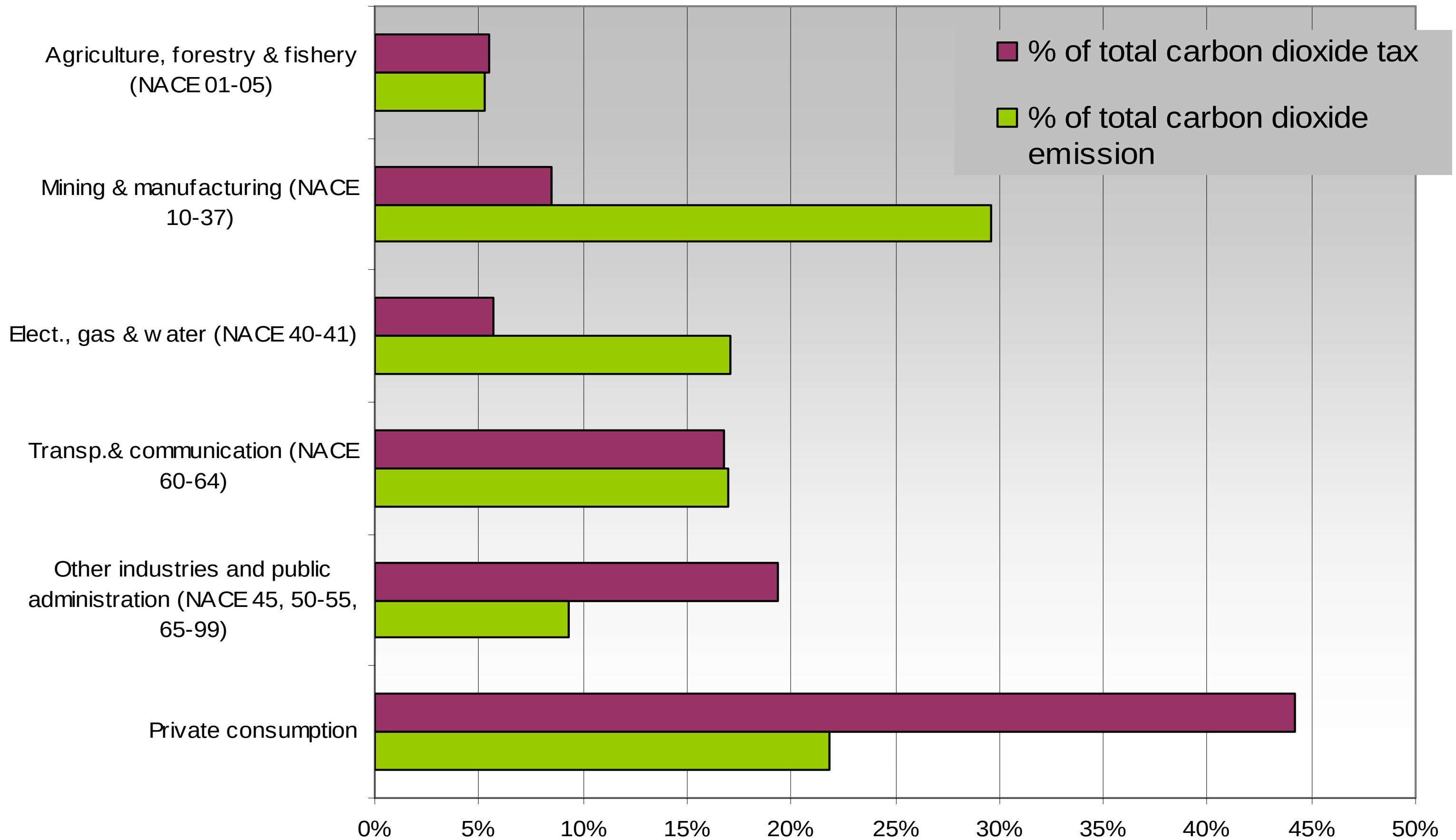
Sectors - Production - Consumption



Integrated analyses



CO2 tax and CO2 emissions by industry



Statistiska centralbyrån Statistics Sweden

Regular publishing

- **Energy use per industry and final demand**
- **Emissions to air**
- **Environmental taxes and subsidies**
- **Environmental protection expenditure**
- **Environmental goods and services**

SCB Miljöräkenskapsdata - analys och simulering - Microsoft Internet Explorer provided by Statistiska Centralbyran ver 8

Arkiv Redigera Visa Favoriter Verktyg Hjälp

Bakåt Sök Favoriter Media

Adress http://www.mirdata.scb.se/MDInfo.aspx Gå till Länk

Statistiska centralbyrån
Statistics Sweden

Environmental Accounts - Analysis and Simulation

Environmental Accounts

- **Introduction**
  - What is Environmental Accounts?
  - Selection of data series
  - Classifications
  - PC-Axis
- **Environmental Accounts data**
  - *From the production side*
    - By industry
  - *From the Final Demand side*
    - Domestic
    - Total
  - *From Private Consumption*
    - Domestic
    - Total
- **Simulating emissions**
  - Background
  - Run the model
    - 7 sectors
    - 52 sectors
- **About the Application**

Introduction

Welcome to the data and analysis site for the Swedish Environmental Accounts.

You can look at and download data on emissions, energy use etc as well as look at indicators, decoupling etc.

Under **Introduction** you can look at the types of emissions, energy and economic variables that are in the database as well as the NACE and COICOP classifications we use.

Under **Environmental Accounts data** you find the data presentedeither by industry or calculated by product group for Final Demand or Private Consumption usning Input-Output analysis.

Under **Simulating emissions** you find a simple simulation model for looking at the links between Final Demand, production, energy intensities and emissions.

Under **About the Application** you find help and the version of the application, the texts and the database.

Environmental Accounts at Statistic Sweden website

Klar Internet

Start SCB Intran... Inbox - Mic... E:\English Microsoft P... System of ... Environme... SCB Miljör... 09

Statistiska centralbyrån Statistics Sweden

Climate relevant analyses

- Economic instruments: subsidies to green fuels, to fossil fuels, energy taxes, green tax reforms (changing tax from employment to energy)
- IO-analyses: decoupling & decomposition analysis
- Household and public consumption
- Environmental goods and services
- Modelling environment/economy

Internal and external drivers for finding the environmental edge on sectoral statistics

Statistiska centralbyrån Statistics Sweden

• Accounting + Environmental management policy. The departments are obliged to identify how data can be linked to environmental data demands from the user side.

• Government investigations, the need for data from authorities, research institutes and universities.

Users advisory group

•The environmental accounts advisory group meet 2-4 times a year.

•It consists of people from the department of finance, department of industry and the department of environment, the Swedish EPA, chemicals authority, Swentec and research and NGOs

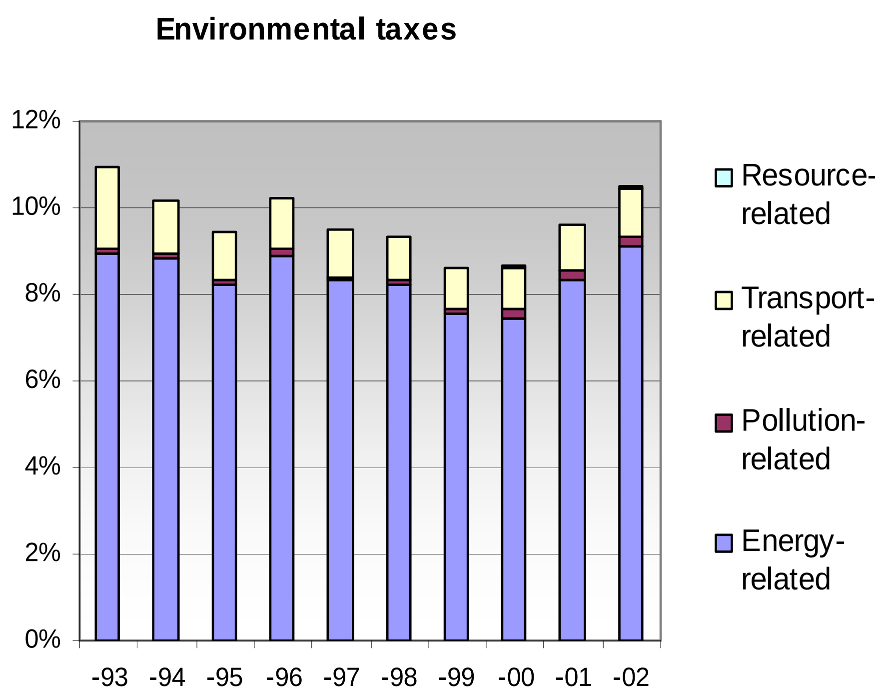
•Advice on future priorities from a user perspective, follow-up yearly work plans.

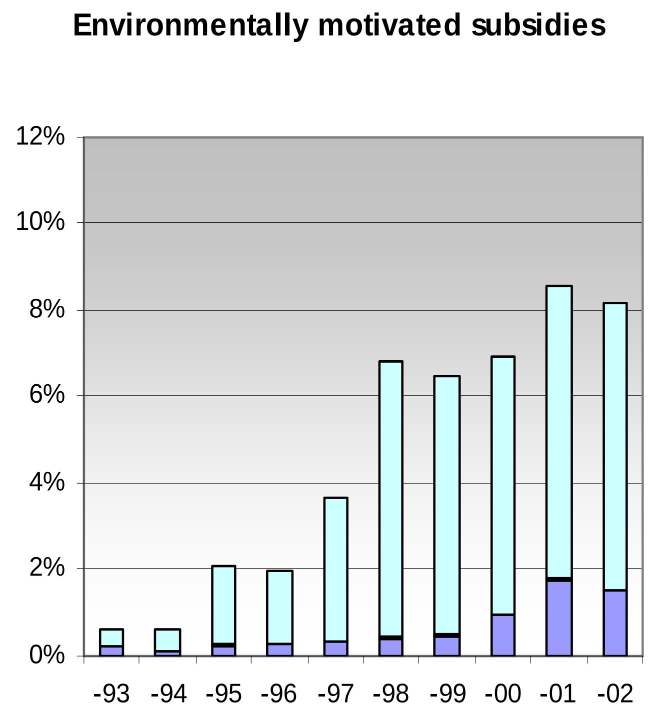
Environmental goods and services: Abatement opportunities

- World market for sustainable energy, i.e. solar power, wind power, hydro power, biogas, district heating, energy efficiency measures, estimated to 165 DEM or 800 billion SEK per year until 2015 (Source: VDEW, the German society for electricity production).
- Environment goods and services database founded on the business register.

Environmental taxes and subsidies – percent of total

Statistiska centralbyrån Statistics Sweden





New developments: Energy subsidy types

Statistiska centralbyrån Statistics Sweden

- ***Direct transfers (to producers, households)***
- ***Public R&D***
- *Preferential tax treatments*
- *Loans*
- *Trade restrictions*
- *Price controls*
- *Infrastructure*

Source: Energy subsidies. Lessons learned in assessing their impact and designing policy reforms. UNEP 2004.

Four climate change and basic statistics challenges

1. Increase availability of data to analysts and modelers. Need for international cooperation. Free access to moderately aggregated data.
2. Engage more with users. Explanations of underlying factors. Knowledge about integrated analysis must be strengthened. Requires new types of expertise in staff. Increased quality through internal cooperation.
3. Include social effects into the dominating environmental economic perspective. Needs investigation.
4. Keep a good balance between the demand for detailed data and the protection of individual and company data.

Agenda for future action

Statistiska centralbyrån Statistics Sweden

- International transport is not covered in CO_2- protocol. Should be included in future international inventory of emissions.
- Energy taxes and subsidies – No regular reporting to the international bodies. SNA reporting and energy reporting. Could become a standard reporting item.
- Dialogue with users to assess data needs and analyses needs. A ‘new’ user group: the modelers of environmental -economic instruments
- Internal work: organization and harmonized classification across sectoral statistics.
- Human resources and financial resources to be found and allocated.
- Coordination of international actions to increase availability of data

DESTATIS wissen. nutzen.

Environment ↔ Economy Toolbox of Official Statistics

Walter Radermacher

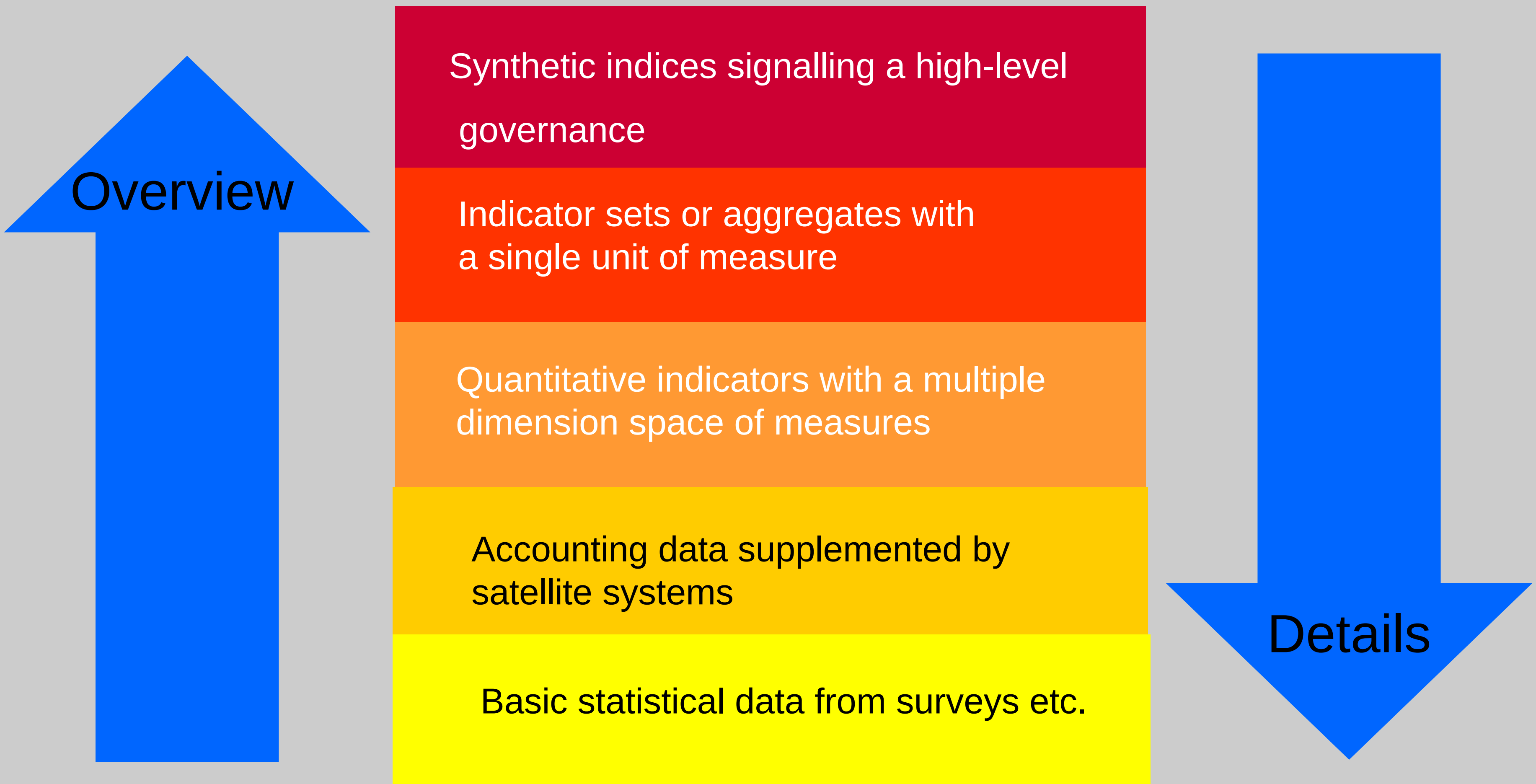
President of the Federal Statistical Office, Germany

Conference on “Climate Change and Official Statistics”

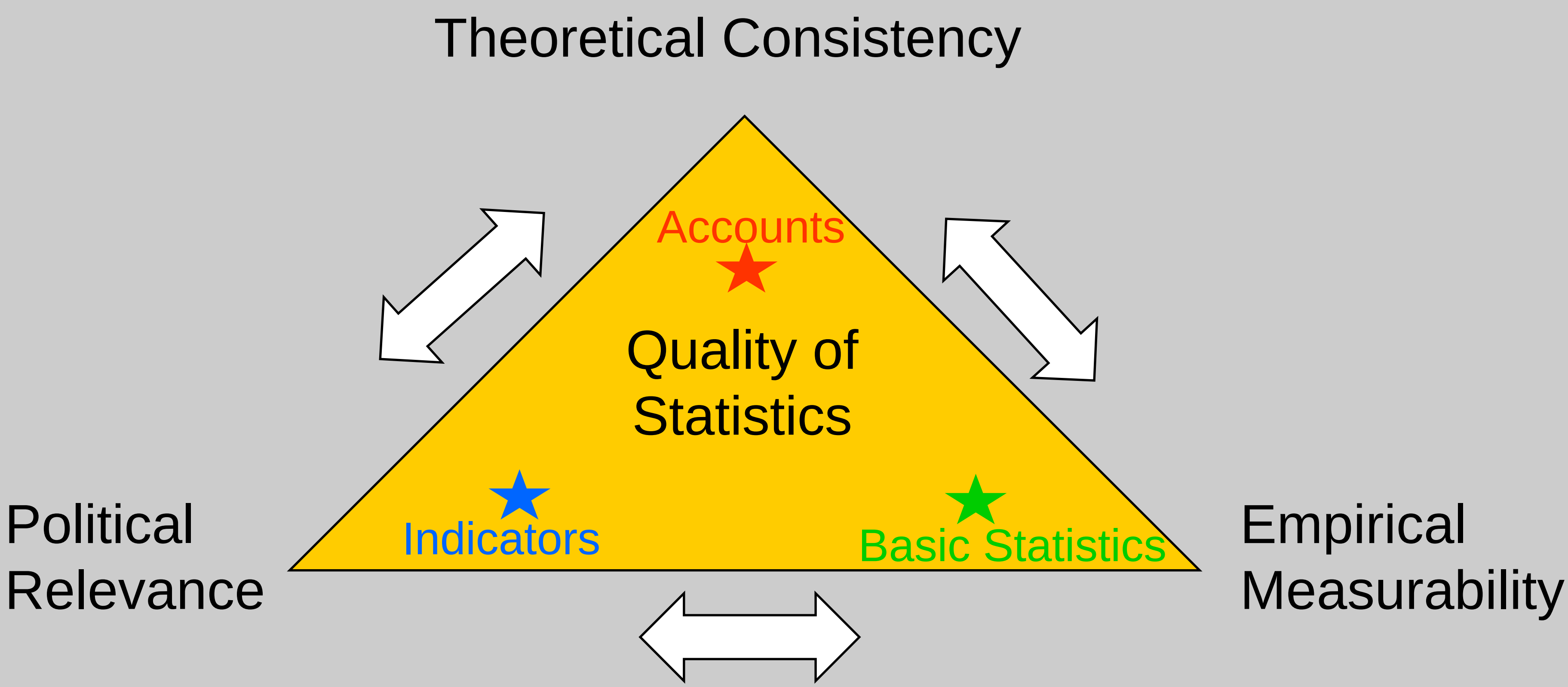
14-16 April 2008, Oslo

Session Seven

Reductionism + Holism: Complementary Views

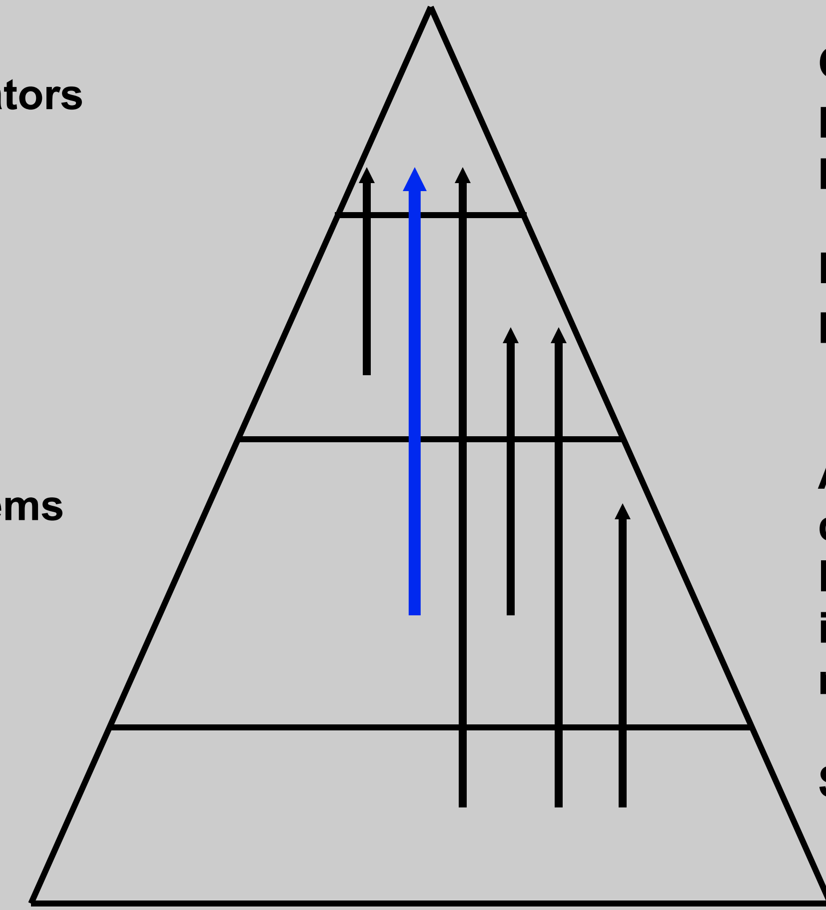


Quality Profile of Statistical Products



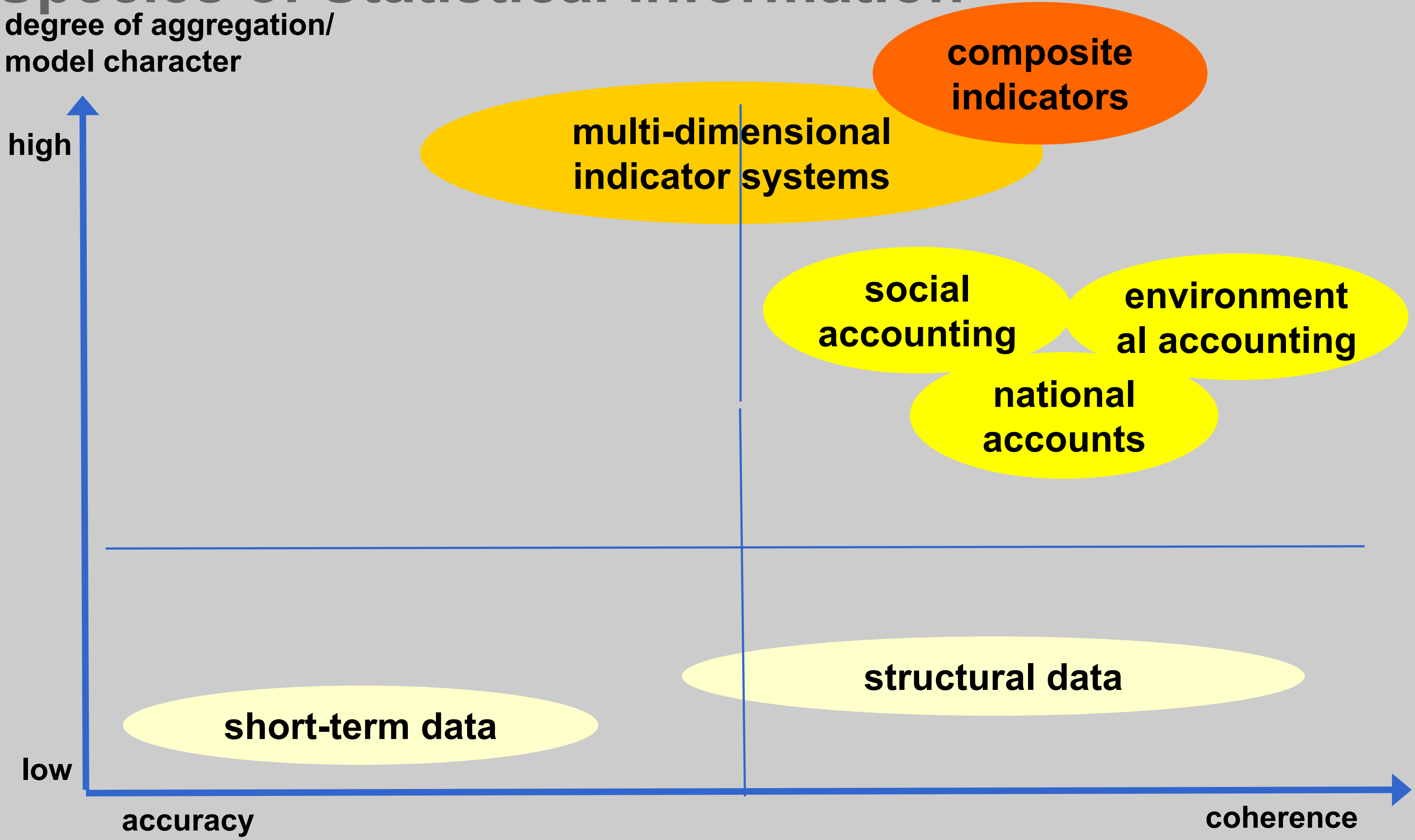
DESTATIS
wissen. nutzen.

Aggregation Pyramid



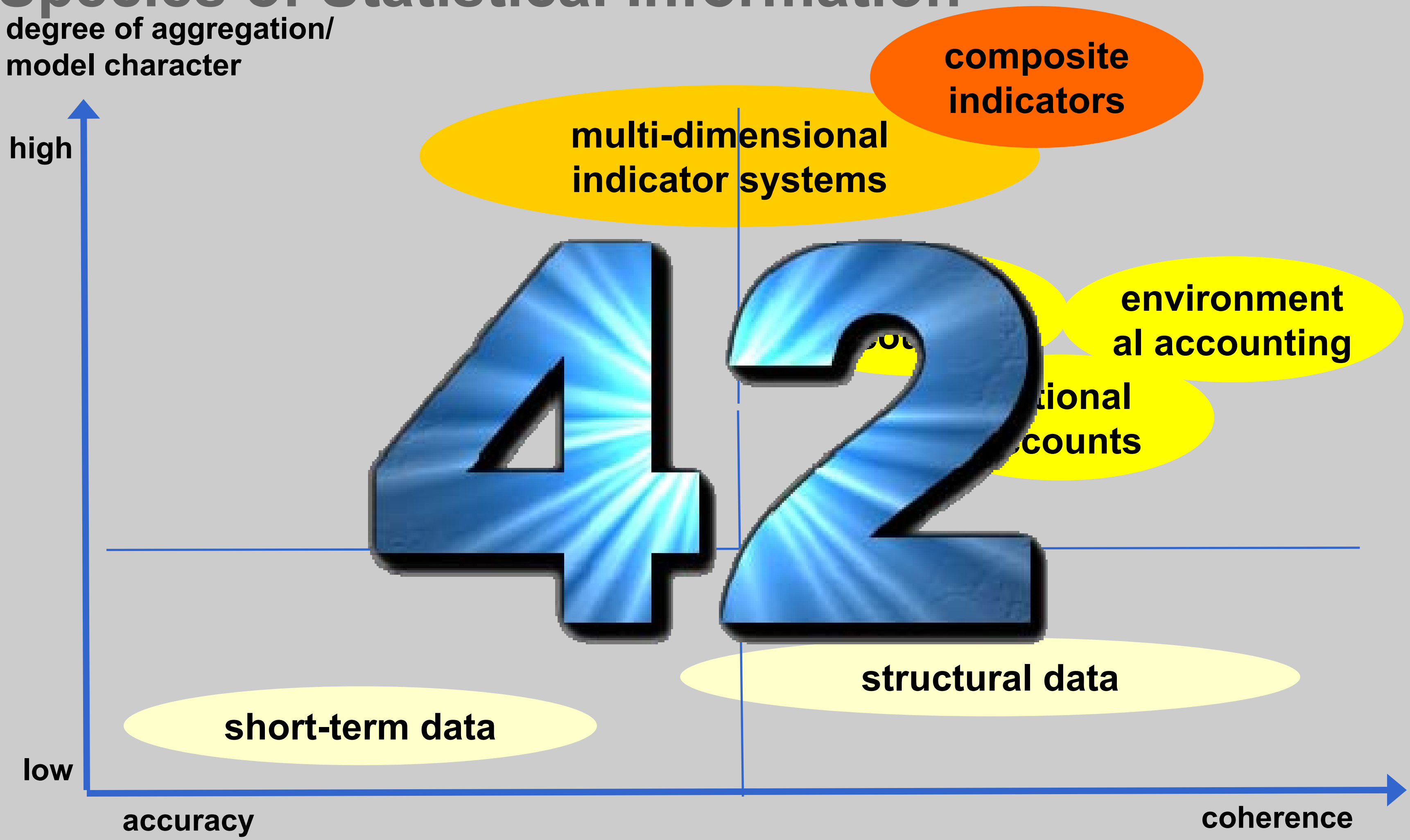
Composite indicators		**Communication of problems, performance control**
Indicator sets		**Detailed description of problems**
Accounting systems		**Analyses of developments and linkages, identification of measures**
Primary data		**Specific analyses**

Species of Statistical Information



DESTATIS
wissen.nutzen.

Species of Statistical Information



DESTATIS wissen. nutzen.

Toolbox Environment Statistics

	Basic Statistics	Geograph. Information Systems	Accounting (SEEA: MFA, Valuation,…)	Modeling	Indicators (Ind. Sets, Composite Ind.)
Collection	X	X			
Systematisation	X	X	X		
Analysis		X	X	X	
Aggregation			X	X	X
Communication					X

Conference on Climate Change and Official Statistics

Oslo, Norway, 14-16 April 2008

COUNTRY PAPERS

Conference on Climate Change and Official Statistics
Oslo, Norway, 14 – 16 April 2008

Aija ZIGURE (Latvian Central Statistical Bureau – Juris FRIDMANIS (Latvian, Environment, Geology and Meteorology Agency)

National Reporting System on Greenhouse Gas Emissions: Latvian Experience

Development of environmental and climate policy in Latvia began with the country`s independence in 1991. A cornerstone for the national climate policy was put when United Nations Framework Convention on Climate Change in Rio de Janeiro UN Conference on Environment and Development in 1992 was signed. Progress towards the development of climate policy supported Latvia`s way towards joining the EU. Before Latvia had not developed special national climate change policy instruments and mitigation efforts were carried out through the combination of environmental protection policies and development strategies of individual economic sectors: energy, transport, agriculture, forestry, industry and waste management.

By ratifying the UN Framework Convention on Climate Change and the Kyoto Protocol, Latvia assumed the commitment of reducing the country`s greenhouse gas (GHG) emissions by 8% in 2008-2012, compared to the 1990 level. In 1990, Latvia emitted 25,894 thousand tons $CO_2$ equivalent, i.e., to meet its Kyoto commitments in the period of 2008-2012, Latvia`s annual emissions may not exceed 23,823 thousand tons CO_2 equivalent [Latvian Environment, Geology and Meteorology Agency, (LEGMA, 2006)]. The greenhouse gas emission forecasts made by the Ministry of Environment suggest that Latvia will meet its commitments under Kyoto Protocol.

Annual inventory of GHG emissions and CO_2 removals as well as National Inventory Report (NIR) is prepared by the Latvian Environment, Geology and Meteorology Agency. The Latvian Central Statistical Bureau (CSB) is the basic statistical and activity data provider to LEGMA. Ministry of Agriculture (MoA), Ministry of Transport (MoT) and enterprises are also co-partners by the elaboration of National Inventory Report. List of the main data and institutions responsible is given. After that when basic data are submitted to LEGMA the NIR is prepared by LEGMA. In separate cases Ministry of Agriculture prepares calculations of GHG emissions and CO_2 removals. The Ministry of Environment is supervising the process of preparation of GHG inventory and NIR.

Touching upon data collection in Latvia, since 2005, an institutional system involved in the gathering and processing of information related to environmental protection and sustainable development and responsible for environmental monitoring (including GHG emissions) and information dissemination to the public has also been developed. The institutions responsible for the Latvian GHG inventory are designated by the Ordinance of the Cabinet of Ministers No 220, also approving the Climate Change Mitigation Programme 2005-2010. A schematic model of the National system is shown in Figure 1

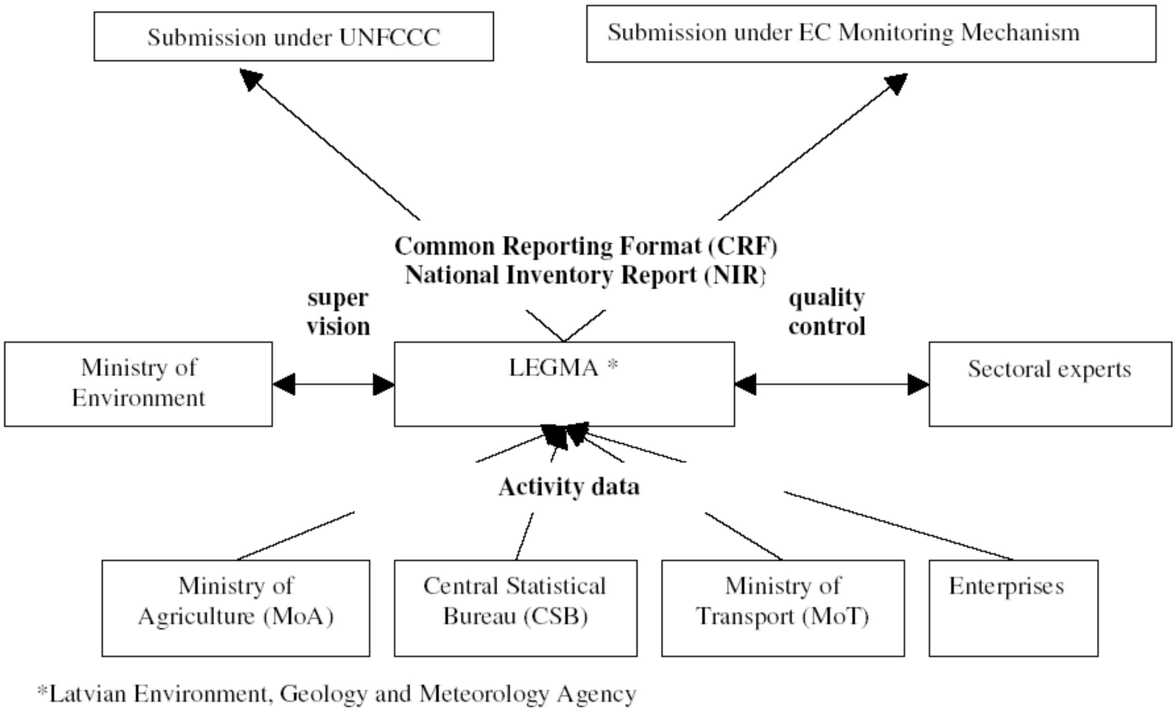


Figure 1. National reporting system on greenhouse gas emissions

The main data sources used for activity data and information and responsible institutions are presented in Table 1.

Sectors	Data Sources for Activity Data and Calculations	Responsible institutions
Energy	Activity data	CSB
	Calculations	LEGMA
Transport	Activity data	CSB, MoT
	Calculations	LEGMA
Industrial processes	Activity data	CSB, Plant operators
	Calculations	LEGMA
Solvent and other product use	Activity data	CSB
	Calculations	LEGMA
Agriculture	Activity data	CSB
	Calculations	LEGMA
Land Use, Land Use Change, Forestry (LULUCF)	Activity data	MoA
	Calculations	MoA, LEGMA
Waste, Wastewater Handling	Activity data	LEGMA
	Calculations	

Table 1. Main data sources for activity data and emission values

A comprehensive Quality control/Quality assurance Plan for Inventory compilation is under development.

Climate Change and Official Statistics

1. National Circumstance

Sri Lanka situated southern tip of India between $6^0 – 10^0$ north latitude and between $80^0 – 82^0$ longitude extending over 65,610 square kilometers frequently influenced its climate by the events Indian Ocean. The Island's central part is mountainous and when extending towards Coast the topography is plane. Although it is a small country, one could see considerable variation in the climate and it could be attributed to the location in the Indian subcontinent and topography. The average annual rainfall varies from 1,000 (39") mm -5,000 mm (197"). Its rain predominantly influenced by two monsoons namely North-east and South-west, thereby creating two major rainy seasons. The mean temperature in the Central peak areas varies from 15 – 19 Celsius while in rest of the areas 25 – 28 Celsius. Major rivers originated at central hills flows in a radial pattern through coastal plains towards the sea.

Sri Lanka's total population at the Census of Population and Housing taken in 1981 was 14.8 million while in 2001 it has reached up to 18.7 and in the year 2007 mid year estimate is 20.01 million. Presently the recorded annual growth is around 1 percent. Population is unevenly distributed across the country. Nearly 2/3 of its total population is confined to wet zone.

Sri Lanka's economy which depended heavily upon agriculture until 1960s basically export oriented plantation crops had started diversifying its nature since last two decades.

Sectoral Share of GDP 1987 – 2007 (at constant prices)

Sector	1987	1998*	2007**
Agriculture forestry and fishery	20.5	17.2	13.0
Mining and quarrying	2.5	1.1	1.9
Manufacturing	19.7	18.2	17.7
Constructions	6.9	6.7	6.4
Services	50.4	56.8	59.6

* Based on 1998 prices ** Based on 2002 prices

Agriculture sector constitutes of two sectors, the produce of plantation crops mainly catered to the export market while small holding or peasantry sector producing mainly for the domestic market. The first sector synthesized with tea, rubber, and coconut, cocoa, coffee, cinnamon, cloves and cardamom mainly catered to the foreign market. Paddy is the main crop which cultivates about 600,000 hectares in the main season and 350,000 hectares in the second season produced for the domestic market. Many species of animals such as neat cattle, buffaloes, swine, goat and poultry are being reared in the country. Fishery sector includes both marine and coastal and also inland fishery sector secured livelihood for a considerable number of its inhabitants.

The climate of Sri Lanka is also conducive to forest cover. One time the forestry cover existed at a considerable share has dropped to less than 2/3 in the land area as a result of deforestation.

Energy supply in Sri Lanka is mainly based on three sources namely; hydro power, biomass and thermal power. However, the contribution from biomass sector is very marginal. Summary data on this sector for the years 2005 and 2006 is given below.

Power Generation Statistics 2005, 2006

Power Stations	**Type**	**No. of Power Stations**		**Installed Capacity In MW.**		**Gross Generation in GWH**	
		2005	2006	2005	2006	2005	2006
C.E.B.	• Total	**23**	**23**	**1758**	**1758**	**5337**	**5951**
	• Hydro	16	16	1207	1207	3173	4290
	• Thermal	6	6	548	548	2162	1669
	• Wind	1	1	3	3	2	2
P.P.P	• Total	**55**	**70**	**652**	**676**	**3432**	**3428**
	• Hydro#	45	60	85	109	5314	346
	• Thermal	10	10	567	567	5	3082
Total		**81**	**93**	**2411**	**2434**	**8769**	**9379**

- with waste heat, Solar, Biomass, Power plants

2. Impacts on Climate Change

Climate Change has a direct impact on the economy, environment, human and animal life. Global warming has significant threat to the Island on following activities.

Source*	**Impact**
Sea level rise	• Coastal settlements • Coastal erosion • Sea water intrusion • Fishery industry • Port activities/Tourism
Temperature rise	• Power Generation • Agriculture and livestock • Human health
Drought	• Ground Water Levels • Power generation • Agriculture/Livestock output • Human Health • Transport facilities
High Intensity of Rainfall	• Land erosion • Land degradation • Agriculture/Livestock output • Human health/hHuman settlements • Power generation

	• Transport Infrastructure
Increased thunder activity	• Damage to infrastructure • Human life risks

3. Official Statistics

Department of Census and Statistics (DCS) is the central agency established to collect compile and disseminate statistics to the Government and its mandate is described below.

3.1 Legal Framework

The legal authority under which DCS operates is governed by two laws; these are the Census Ordinance 1956 (amended in 2000) and the Statistics Ordinance. These two ordinances explain the duties and responsibilities of the Head of the Department and the staff while collecting data through the means of Censuses and surveys and it prevents any form of abusing its rights or powers. The law dictates what the statistical agency is expected to do with the information when respondents submit to it. Respondents are asked to comply with the statistical agency's demands for information so long as they can be justified in the name of the objectives set by the law. In exchange for intrusion upon privacy rights, the statistical agency is required to safeguard respondents' information. If the agency breaks this commitment, its officers are subject to certain sanctions. If respondents do not comply, they too are subject to certain sanctions.

Census Ordinance.

The first legal sanction in Sri Lanka provided under the Census Ordinance was framed in 1868 on the lines of the English law for the conduct of the first Census in 1871.This ordinance was amended in 1880 and also in 1900. By these amendments, it has made provisions to undertake the Census with legal wrights by accessing defined census units by the census officer and request for the information needed for the purpose of census taking. It also spells out the obligations of respondents by giving answers to the best of their knowledge and belief. If the Census officers violates Census regulations or abuse of powers or respondents obstructing an officer in carrying out his duties are liable to be punished. The Census Ordinance has undergone with amendments in 1945, 1955, 1980 and 2000. The Census ordinance covers not only the Census of Population and Housing but also Agriculture, Industry, Commerce etc. The amendments made in1980 include the provision of legal sanctity for the confidentiality of the information collected at the Census. Thus the Census Ordinance casts an obligation on the part of the respondents to answer all questions asked at a Census and at the same time it safeguards the respondents by causing any information collected at a Census to be inadmissible as evidence in a Court of law. Extract of the Census and Statistical law is annexed.

Statistics Ordinance.

The Statistics Ordinance which was enacted in1935 provides for the establishment of an official Bureau of Statistics and for the supply of information thereto. This ordinance was amended in 1955. The Statistics Ordinance provided legal sanction for the Director of Census and Statistics to collect statistical information relating to the socio-economic conditions of the country. There is provision in this ordinance like in the Census Ordinance to safeguard the confidentiality of the information provided by the respondent. The ordinance also prevents the disclosure of identity of any information in respect of an individual person for any purpose other than disseminating aggregate information for decision making.

However, these ordinances do not spell out any mechanism for ensuring coordination between different agencies of the government that are engaged in data gathering as a part of their administrative purposes.

3.2 Organization of DCS

The statistical system functioning in Sri Lanka is known to be centralized one and the Department of Census and Statistics (DCS) is the National Statistical Office in Sri Lanka mainly responsible for the collection, compilation and dissemination of statistical data requirements of the government. Apart from its responsibility of collecting and supplying data on the various sectors of the socio-economic conditions of the country, it recruits train and place professional staff of all government agencies requiring statistical services. In addition to that it provides statistical consultancy services to the agencies require assistance, on statistical matters, through its technical divisions. As such the DCS service as a focal point and performs the services of a central statistical agency.

The DCS is the main government statistical agency is entrusted with the responsibilities data collection pertaining to economic and social life f the inhabitants and dissemination, as well as coordination of, personnel recruitment and training for, and provision of technical services to, the entire statistical system. DCS is headed by a Director General with equivalent rank of Additional Secretary who at present reports directly to the Ministry of Finance and Planning. DCS is operating its functions through 18 technical and service divisions housed in different locations in the city of "Colombo." These divisions are headed by either Directors or Deputy Directors.

DCS operates its principal office and technical divisions in Colombo with an island wide net work of field offices and field officers attached to district secretariats and Divisional Secretariats and also branch offices in key Ministries and Departments.

The collection and compilation of data is performed through the staff attached to 25 District Statistical Offices, located in the District Secretariats. Each office is under the charge of a Deputy Director/Senior Statistician/ Statistician, who is assisted by a team of Statistical Officers attached to the Divisional Secretary's office. These officers are engaged in training and monitoring of data collections performed by primary reporters as well as they do collect data themselves for certain surveys that they are entrusted by the technical divisions.

The DCS maintains 40 branch offices at present in various Ministries, Departments and other governments agencies, which are placed in charge of either a Deputy Director, Senior Statistician, Statistician or Statistical Officer. The statistical personal in these branch offices are under the immediate administrative control of their respective Heads of Ministries, Departments, even though they belong to the cadre of the DCS. However they obtain advice and guidance from the technical divisions of the DCS. DCS does not have a direct input in the development of the work plans of line ministries, but contributes to technical improvements to data collection activities in these ministries through the professional staff based in these branch offices. In theory, DCS HQ units have technical oversight of the statistical units in the line Ministries.

As mentioned earlier DCS is responsible for collection, compilation and dissemination of all type of socio-economic information comply with the vested power and legal authority under the Census ordinance and statistical ordinance. The statistical programs undertaken by DCS are as follows.

1. Conducting annual/biannual sample surveys under current statistical program
2. Conducting ad-hoc surveys depending on national requirements.
3. Collection of statistics through administrative records.
4. Conducting the Censuses in different disciplines.

The data disseminate by DCS based on the above sources are published in the Statistical Abstract and they are available to the public by means of hard copies, electronic media and website. A concise summary of list of statistical tables are given below.

References: 1. Initial National Communication Under The United nations Framework Convention on Climate Change- Sri Lanka 2000 October – Ministry of Forestry and Environment
2. Statistical Abstract 2007- Department of Census and Statistics
3. Guide to Statistics – Department of Census and Statistics

Areas Covered by Official Statistics

- AREA AND CLIMATE

Area

1.1 Area of Sri Lanka by province and district
1.2 Land area by province, district and D.S division

Climate

1.3 Mean annual and monthly air temperature at observation stations, 1999 – 2006
1.4 Mean monthly minimum and maximum air temperature at observation stations, 2002 – 2006
1.5 Mean annual and monthly relative humidity, 2002 - 2006
1.6 Mean annual and monthly rainfall at observation stations, 2002 - 2006

– POPULATION

2.1 Population by sex and district, census years
2.1a Estimated mid year population by district, 2002 – 2006
2.2 Urban population by sex and district, census years
2.3 Rural population by sex and district, census years
2.4 Population of principal towns by sex, census years
2.5 Estimated mid year population by sex and age, 2003 -2006
2.6 Population distribution by sex , age and district , Census 2001
2.7 Population by D.S. Division and sex, Census 2001
2.8 Population density by district, census years
2.9 Disabled persons by sex and district , Census 2001

Ethnic Group and Religion

2.10 Population by ethnic group, census years
2.11 Population by ethnic group and district, Census 1981,2001
2.12 Percentage distribution of population by ethnic group and district, Census 1981, 2001
2.13 Estimated mid year population by ethnic group, 1980 - 1989
2.14 Population by religion, census years
2.15 Population by religion and district, Census 1981, 2001
2.16 Percentage distribution of population by religion and district, Census 1981, 2001
2.17 Number of housing units, households and average household size by district , Census 1971,1981,2001
2.18 Building units distribution by type of unit by district, Census 2001

- VITAL STATISTICS
Natality

3.1 Live births by sex, sex ratio at birth, and crude birth rate, 1965 - 2005
3.2 Live births by district, 1996 - 2005
3.3 Live births by age of mother, 1980 - 2001

Foetal, Infant and Maternal Mortality

3.4 Foetal deaths by sex and foetal deaths per 1000 live births in proclaimed towns, 1965 - 1999
3.5 Infant mortality per 1000 live births by district, 1991 - 2003
3.6 Maternal deaths per 100,000 live births by district, 1987 - 1999

General Mortality

3.7 Number of deaths by sex and crude death rate, 1961 – 2005
3.8 Number of deaths by district, 1996 – 2005
3.9 Number of deaths by age and sex, 1995 – 2001
3.10 Deaths by cause, 1998 - 2001
3.11 Deaths by cause and age groups, 1998-2001

3.12 Life expectancy at specified ages by sex, 1963, 1971 and 1981
3.13 Number of survivors at specified ages by sex, 1963, 1971 and 1981

Nuptiality

3.14 Population by marital status, age group and sex, Census 2001
3.15 Marriages by type, civil condition, age of groom and age of bride, 1997 - 2003
3.16 Marriages by district, 1997 - 2005
3.17 New contraceptive acceptors per 1000 married women by age group for all methods, 2005 -2006
3.18 New acceptors of temporary methods of family planning by age groups, 2005 - 2006
3.18a New acceptors of permanent methods of family planning by age groups, 2004 - 2006

Migration

3.19 Lifetime internal migration, 1971 and 1981
3.20 Arrivals and departures by nationality, 2006
3.21 Movement of population - Natural increases and net gain or loss by migration

- LABOUR AND EMPLOYMENT

4.1 Labour force participation (current) of the household population, 10 years of age and over - All Island
4.1a Labor force participation (current) of the household population, 10 years of age and over by sex - All Island
4.2 Currently employed persons by major industrial groups (percentage) - Both sexes
4.2a Currently employed persons by industry group (based on ISIC third revision)
4.3 Currently employed persons by major occupational groups (percentage) - Both sexes
4.3a Currently employed persons by occupational group (based on ISCO 88)
4.4 Employed population aged 10 years and over by major industry division and sex, Census 2001
4.5 Employed population aged 10 years and over by major occupational group and sex, Census 2001
4.6 Poverty headcount ratio by district
4.7 Percentage of poor households based on the official poverty line by district
4.8 Employees’ provident fund, 1983 – 2006
4.9 Employees’ trust fund board, 1987 - 2006
4.10 Average minimum wage rates and average earnings by sector, 1989 - 2006
4.11 Index numbers of minimum wages (base 1978 = 100), 1998 – 2006
4.12 General wage rate (minimum) index numbers (base 1978 = 100) for tea and rubber estate Laborers and unskilled workers in government employment, 1998 - 2006
4.13 Trade unions, 1995 - 2006
4.14 Number of strikes, workers involved and man days lost, 1995 – 2006
4.15 State sector, provincial public sector and semi-government sector employees by occupational groups and status of employment, 1st July, 2002
4.15a Distribution of employees by sector, sex and age, 2006
4.16 State sector, provincial public sector and semi-government sector employees by monthly gross salary group , 2002
4.17 Employment statistics of corporations, statutory boards, Authorities and public private companies, 2005

4.18 Departures for foreign employment by country and sex, 2002 – 2006
4.19 Departures for foreign employment by country and man power level, 2005 - 2006

– AGRICULTURE , FORESTY AND FISHERIES

AGRICULTURE

Extent

5.1 Cultivated extent of crops, 2002 – 2006
5.2 Cultivated extent of tea, rubber and coconut by district
5.3 Paddy: Extent sown and harvested by irrigation scheme, 1998 - 2006, maha and yala
5.4 Paddy: Extent sown and harvested by irrigation scheme and district, maha 2002 / 2003 - yala 2006
5.5 Paddy : Gross asweddumised extent by irrigation scheme and cultivation year, 1986 / 87 –2005 / 06
5.6 Paddy: Gross asweddumised extent by irrigation scheme and district, 2002 /2003 - 2005 / 2006 159
5.7 Paddy: Extent sown by variety of seed, 1998 - 2006 maha and yala
5.8 Paddy: Extent sown by variety of seed and district, maha 2002 / 2003 - yala 2006
5.9 Paddy: Extent sown by method of sowing, 1999 – 2006, maha and yala
5.10 Paddy: Extent sown by method of sowing and district, maha 2002 /2003 - yala 2006
5.11 Paddy: Extent sown by method of land preparation, 1999 - 2006 maha and yala
5.12 Paddy: Extent sown by method of land preparation and district, maha 2002/2003 - yala 2006
5.13 Paddy: Extent sown by method of weeding, use of insecticide and use of fungicide, 1999 - 2006, maha and yala
5.14 Paddy: Extent sown by method of weeding and district, maha 2002 / 2003 - yala 2006
5.15 Paddy: Extent sown by application of fertilizer, 2001 – 2006 maha and yala
5.16 Paddy: Extent sown by type of fertilizer used and district, Maha 2002 / 2003 - Yala 2006
5.17 Cultivated extent of highland crops by district, maha 2004 / 2005 - yala 2006

Production

5.18 Volume index of agriculture and livestock production, 2000 -2006
5.19 Production of crops, 2002 - 2006
5.20 Paddy : Production and average yield per net hectare by district, maha 2003 / 2004 - yala 2006
5.21 Production of highland crops by district, maha 2004 /2005 - yala 2006

Cost of Production

5.22 Cost of production of tea per kilogramme, 2001 / 02 - 2005 / 06
5.23 Cost of production of rubber per kilogramme, 2001 / 02 - 2005 / 06
5.24 Cost of production of coconut per 1000 nuts, 2001 / 02 - 2005 / 06

Livestock

5.25 Livestock population, 1998 - 2006
5.26 Livestock slaughtered, 1998 - 2006

5.27 Supply of calories, protein and fat per day per person, 1998 - 2005
5.28 Food balance sheet, 2001 - 2005 (Revised)

FORESTRY

5.29 Area of forests, 2001-2006 234
5.30 Area of wild life reserves, 1998- 2005
5.31 Production of timber, 1999 - 2006

FISHERIES

5.32 Basic statistics of marine fisheries , 2006
5.33 Fish production by fishing sub-sectors, 1990 - 2006
5.34 Marine sector fish production by fisheries districts, 2001 - 2006
5.35 Marine fish production by major commercial groups,2001 - 2006
5.36 Quantity and value of exports of fish and fishery products, 2002 - 2006
5.37 Quantity and value of imports of fish and fishery products, 2002 - 2006
5.38 Local production and imports of dried fish, 1994 - 2006
5.39 Operating fishing crafts, 1995 - 2006

- INDUSTRIAL PRODUCTION , CONSTRUCTION AND ENERGY

INDUSTRIAL PRODUCTION

6.1 Employment statistics of BOI enterprises, 2001 -2006
6.2 Principal indicators of industrial activity classified by province, 2003 (all establishments)
6.3 Principal indicators of industrial activity classified by major industry division, 2003 (all establishments)
6.4 Principal indicators of industrial activity classified by industry division, 2003 (all establishments)
6.5 Principal indicators of industrial activity classified by persons engaged size class, 2003 (all establishments)
6.6 Principal indicators of industrial activity classified by output size class, 2003 (all establishments)
6.7 Principal indicators of industrial activity classified by district, 2003 (all establishments)

CONSTRUCTION

6.8 Some selected indicators of construction activities classified by type of construction activity , 2003 - 2004
6.9 New buildings constructed, additions and alterations within municipalities by district , 2006
6.10 New buildings constructed, additions and alterations within urban councils by district , 2006
6.11 New buildings constructed, additions and alterations within pradeshiya sabhas by district , 2006

ENERGY

6.12 Energy statistics , 2002 – 2006

– TRANSPORT AND COMMUNICATION

Road Transport

7.1 Length of public roads, 2002 - 2006
7.2 Number of motor vehicles on registers as at 31st December of each year, 2002 -2006
7.3 New vehicles registered by class of vehicles and type of fuel used, 2001 - 2006
7.4 Number of road accidents reported to police, 2000 – 2005
7.5 Road accidents reported to police in the city of Colombo by police area, 1999 – 2004
7.6 Number of persons killed in road accidents, 2000 – 2005
7.7 Number of persons injured in road accidents in the city of Colombo, 1999 – 2004
7.8 Omnibus services, 2005 - 2006

Railway Transport

7.9 Length of railway track open for traffic, 2002 - 2006
7.10 Locomotives and rolling stock, 2002 - 2006
7.11 Passengers and goods traffic, 2001 - 2006

Sea Transport

7.12 Ship traffic by port, 2000 - 2006
7.13 Cargo throughput Ports of Colombo, Trincomalee and Galle, 1997 - 2006
7.14 Total tonnage of cargo handled, 2000 - 2006
7.15 Average waiting time, service and turnaround time per ship and average tons per ship hour at berth and in port for non container ships and container ships, 2000 - 2006

Air Transport

7.16 Passengers carried by airlines, 2005 - 2006
7.17 Mails carried by airlines, 2005 - 2006
7.18 Freight and excess baggage carried by airlines, 2005 - 2006

COMMUNICATION

7.19 Telecommunication and postal services, 2000 - 2006
7.20 Number of libraries in Sri Lanka, 2006 - 2007
7.21 Number of periodicals published by subject, 2005
7.22 Number of news papers in circulation , 1998 - 2005

– PRICES

8.1 Annual averages of the Colombo Consumers' Price Index by major groups and annual rate of change, 1962-2006
8.1a Annual averages of the Greater Colombo Consumers' Price Index by major groups, 1990-2006
8.1b Sri Lanka Consumers' Price Index, 1999 – 2007 April
8.2 Retail prices of commodities Colombo Town, 2002-2006
8.3 All Island selected retail prices , 2002-2006
8.4 Farm - gate prices of paddy, 2001-2006
8.5 Annual average retail prices of fresh fish – Colombo , 1999-2006
8.6 Annual average wholesale prices of fresh fish – St. John's market (Colombo) ,1999-2006
8.7 Monthly average wholesale prices of fish at Colombo , 2005 -2006
8.8 Monthly retail prices of fish at Colombo , 2005 -2006
8.9 Wholesale prices of local dried fish(Pettah), 2005 -2006
8.10 Wholesale prices of imported dried fish (Pettah), 2005 -2006
8.11 Retail prices of dried fish (Colombo & Suburbs markets), 2005 -2006
8.12 All Island producer prices of selected items, 2002-2006
8.13 Producer prices for selected items of highland crops by province and district, 2006
8.14 Producer prices for selected items of livestock by province and district, 2006

- TRADE AND BALANCE OF PAYMENTS

Trade

9.1 Summary of foreign trade statistics, 1982-2006
9.2 Composition of exports, 2002 - 2006
9.3 Composition of imports, 2002 - 2006

9.4 Quantity and value of imports of major commodities, 1990-2006
9.5 Quantity and value of exports of major commodities, 1990-2006

Balance of Payments

9.6 Current and capital transactions, 2005 -2006

- NATIONAL ACCOUNTS

10.1 Summary indicators, 2002 – 2006
10.2 Gross Domestic Product by industrial origin at current producer prices , 2001- 2006
10.3 Gross Domestic Product by industrial origin at constant(2002) prices , 2002 - 2006
10.4 Gross Domestic Product (value added) in agricultural sector at current producers’ prices by industrial activities, 2002 - 2006
10.5 Gross Domestic Product (value added) in agricultural sector at constant (2002) prices by industrial activities, 2002 – 2006
10.6 Expenditure on Gross Domestic Product at current prices, 2002-2006
10.7 Reconciliation of key aggregates, 2002 - 2006
10.8 Government final consumption expenditure by purpose at current prices, 2002 - 2006
10.9 Government final consumption expenditure by purpose at constant (2002) prices, 2002- 2006
10.10 External transactions on current account, 2003 - 2006

– FINANCE AND BANKING

11.1 Central government income, 2001 – 2006
11.2 Voted expenditure of the government of Sri Lanka, 2005 - 2006
11.3 Capital payments of central government, 1999 - 2006
11.4 Composition of public debt, 1985 - 2006
11.5 Liabilities of commercial banks, 1999 - 2006
11.6 Assets of commercial banks, 1999 - 2006
11.7 Money supply, 1989 - 2006
11.8 Money rates of interest, 2001-2006
11.9 Savings deposits and savings certificates, 1978 - 2006

- CO - OPERATIVE DEVELOPMENT

12.1 Number of co - operative societies, 2000 – 2006
12.2 Membership of co - operative societies, 2000 - 2006
12.3 Liabilities of co - operative societies, 2001 - 2005
12.4 Assets of the co - operative societies, 2001- 2005
12.5 Turnover of the co - operative societies by type of society, 2001 - 2005
12.6 Loans granted by rural co - operative credit societies to its members by purpose, 2002 – 2006
12.7 Vital statistics of co-operative rural banks, 2002 - 2006

- SOCIAL CONDITIONS

Public Health

13.1 Number of government hospitals, beds, personnel, patients treated and expenditure on health services, 2000 – 2005
13.2 Relief of widespread distress and unemployment relief, 1998 – 2005

Pensions and Gratuities

13.3 Expenditure under the pension payments, 2000 – 2006
13.4 Number of contributors under the widows and orphans and widowers and orphans pensions, 2001 – 2006
13.5 Total number of new pensioners, 2006

Charitable Allowances

13.6 Industrial accidents settled and compensation paid, 2000 – 2005

Justice and Crime

13.7 Strength of police force, 2000 -2006
13.8 Receptions, average population, deaths and expenditure of prisons, 2000 – 2006
13.9 Convicted prisoners with previous proved offences, 2002 - 2006
13.10 Convicted persons by ethnic group and sex, 1999- 2006
13.11 Unconvicted persons by ethnic group and sex, 1999 - 2006
13.12 Convicted persons by religion and sex, 2000 -2006
13.12a Convicted prisoners according to narcotic drugs and excise offences, 2000 -2006
13.13 Unconvicted persons by religion and sex, 2001 - 2006
13.14 Grave crimes by type of crime, 2002-2006
13.15 Direct admission of convicted prisoners by type of offence , 2001 – 2006

- EDUCATION

14.1 Population (10 years and over) by literacy and sex, Census years
14.2 Literacy rates of persons 10 years of age and over by district and sex, 2001
14.2a Percentage distribution of population (10 years and over) by ability to speak , read and write by sex and district, Census 2001
14.2b Percentage distribution of population (5 years and over) by educational attainment by sex and district, Census 2001
14.3 Number of schools, pupils, teachers and pupil teacher ratios by type of school, 1997 -2006
14.4 Number of schools by type of school and district, 2004 -2006
14.4a Number of functioning schools by medium, gender and district, 2004 -2005
14.5 Number of pupils in schools by type of school classified by district, 2003 - 2006 362
14.6 Number of teachers in schools by type of school and district, 2003 - 2006
14.7 Number of government schools by grade and district, 2003 - 2006
14.8 Number of government schools by functional grade, 2001 - 2006
14.9 Number of pupils on registers classified by type of school attended , 2001 - 2006
14.10 Teachers in schools classified by qualifications (excluding pirivena teachers),2000-2005
14.11 Distribution of government schools, pupils and teachers by district , 2001 - 2006
14.12 performance of candidates (G.C.E. O/L) and (G.C.E. A/L), 2000 – 2006
14.13 Institutions of higher learning by number of departments, teachers, students, income and expenditure,1994 -2004
14.14 Number of students by university and major courses of study, 1999 - 2006
14.15 Technical colleges classified by type, number of colleges, students, staff and expenditure, 2000 – 2006
14.16 Number of undergraduate entrants by university, academic stream and sex, 2003-2006
14.17 Number of postgraduate students enrolment by university and academic stream, 2002 – 2006

- LOCAL GOVERNMENT STATISTICS

15.1 Area, population, registered voters and employees of municipalities, 2005 -2006 389
15.2 Number of registered voters and employees of urban councils 2005 -2006
15.3 Number of registered voters and employees of pradeshiya sabhas, 2005 -2006
15.4 Revenue of municipal councils and urban councils, 2004-2005
15.5 Revenue of pradeshiya sabhas, 2005 -2006
15.6 Expenditure of municipal councils and urban councils, 2004 -2006
15.7 Expenditure of pradeshiya sabhas, 2005 - 2006

– ELECTORATES

16.1 Total population, under 18 years, 18 years and above by sex and district, Census 2001
16.2 Results of Presidential election by electoral district, 2005
16.3 Results of Parliamentary general election by electoral district, 2004
16.4 Parliamentary general elections – 2000 , 2001, 2004 ,
allocation of seats on electoral district and national basis
16.5 Registered electors by electoral district and polling division, 2001 - 2005

– TOURISM

17.1 Tourist arrivals by country of nationality, 2002-2006
17.2 Tourists classified by purpose of visit, 1998 - 2006
17.3 Tourist arrivals by country of residence, 2001 - 2006
17.4 Tourist growth trends, 1991 -2006
17.5 Direct employment in the tourist industry, 2005 - 2006